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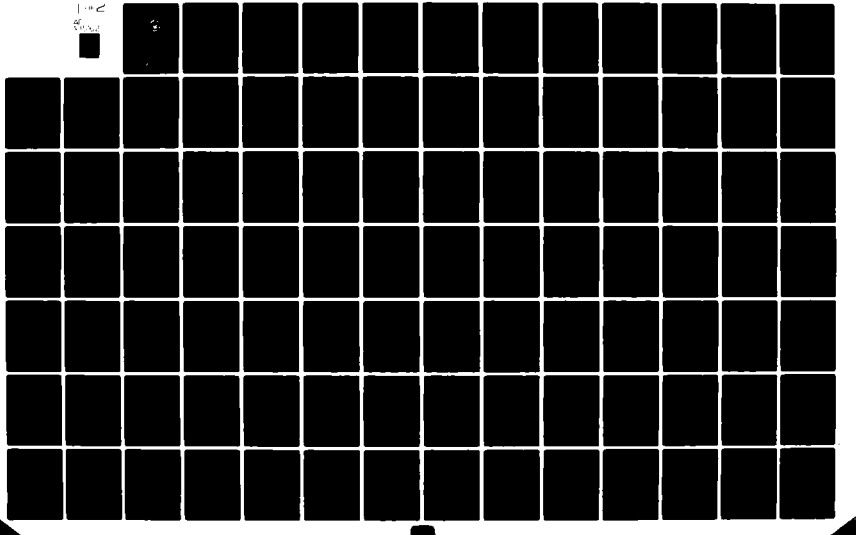

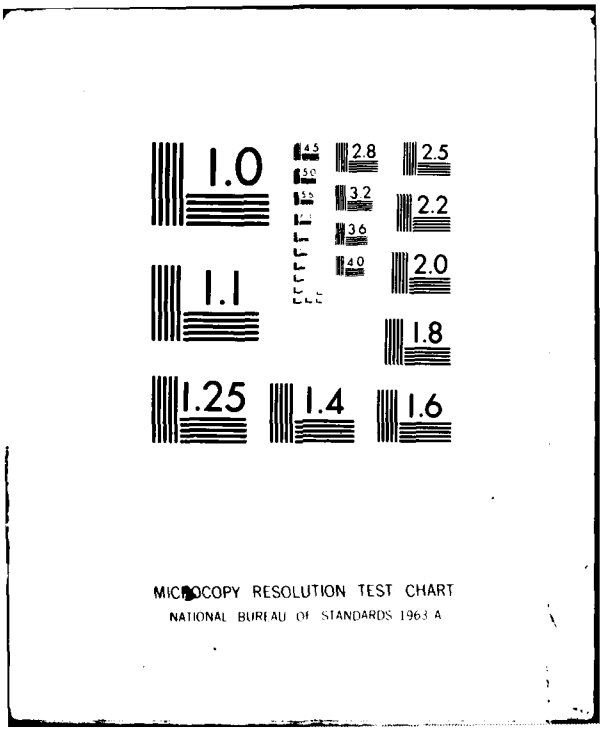
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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

AN ANALYSIS
FOR CAPITAL EXPENDITURE DECISIONS
AT A NAVAL REGIONAL MEDICAL CENTER

by

Martin Edward Doyle III

December 1981

Thesis Advisor: R. A. Bobulinski

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This thesis addresses the problem encountered by non-profit medical centers in formulating budgets for capital expenditure decisions. Using Naval Regional Medical Center (NRMC) San Diego as an example a benefit/cost model was developed. The costs used in the authors analysis were those that were considered to be relevant and incremental. The benefits derived were a composite weighting of four factors determined from a survey of the chiefs of service at NRMC

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San Diego. These four factors are utilization rate of equipment, life-saving potential, greater dependability of service and better diagnosis and evaluation of patient needs. The composite rating was then extended over the estimated economic life of the equipment and divided by the net cost to determine an index of service. Finally, equipment proposals were ranked by index of service. This model was determined by the author and senior hospital administrators to be very useful in tentative ranking of equipment proposals.

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An Analysis for Capital Expenditure Decisions at a Naval Regional Medical Center

by

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Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1970

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

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December 1981

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ABSTRACT

This thesis addresses the problem encountered by non-profit medical centers in formulating budgets for capital expenditure decisions. Using Naval Regional Medical Center (NRMC) San Diego as an example a benefit/cost model was developed. The costs used in the authors analysis were those that were considered to be relevant and incremental. The benefits derived were a composite weighting of four factors determined from a survey of the chiefs of service at NRMC San Diego. These four factors are utilization rate of equipment, life-saving potential, greater dependability of service and better diagnosis and evaluation of patient needs. The composite rating was then extended over the estimated economic life of the equipment and divided by the net cost to determine an index of service. Finally, equipment proposals were ranked by index of service. This model was determined by the author and senior hospital administrators to be very useful in tentative ranking of equipment proposals.

TABLE OF CONTENTS

I. INTRODUCTION TO THE STUDY

A. BACKGROUND

The literature indicates that the ultimate direction, growth, and strength of a business enterprise are determined, to a large extent, by the expenditures that are made for buildings and equipment. These expenditures are frequently referred to as capital expenditures. They are important because of the effect they have on the operating framework of a company, of the large amount of funds involved and their long term effect of these expenditures. Since capital expenditures are of such importance, it is only logical that management should judiciously use all of the techniques available in making decisions regarding them.

During the past several years a great deal of attention has been devoted to capital expenditure analysis for profit-seeking enterprises. A literature search conducted by the author indicates that, until recently, little has been published directed at the analysis of capital expenditures of non-profit enterprises. What little has been published is so recent that there has been insufficient time for implementation and evaluation to identify an effective system or systems.

Hospitals represent an important segment of the non-profit enterprises both in terms of the size of the

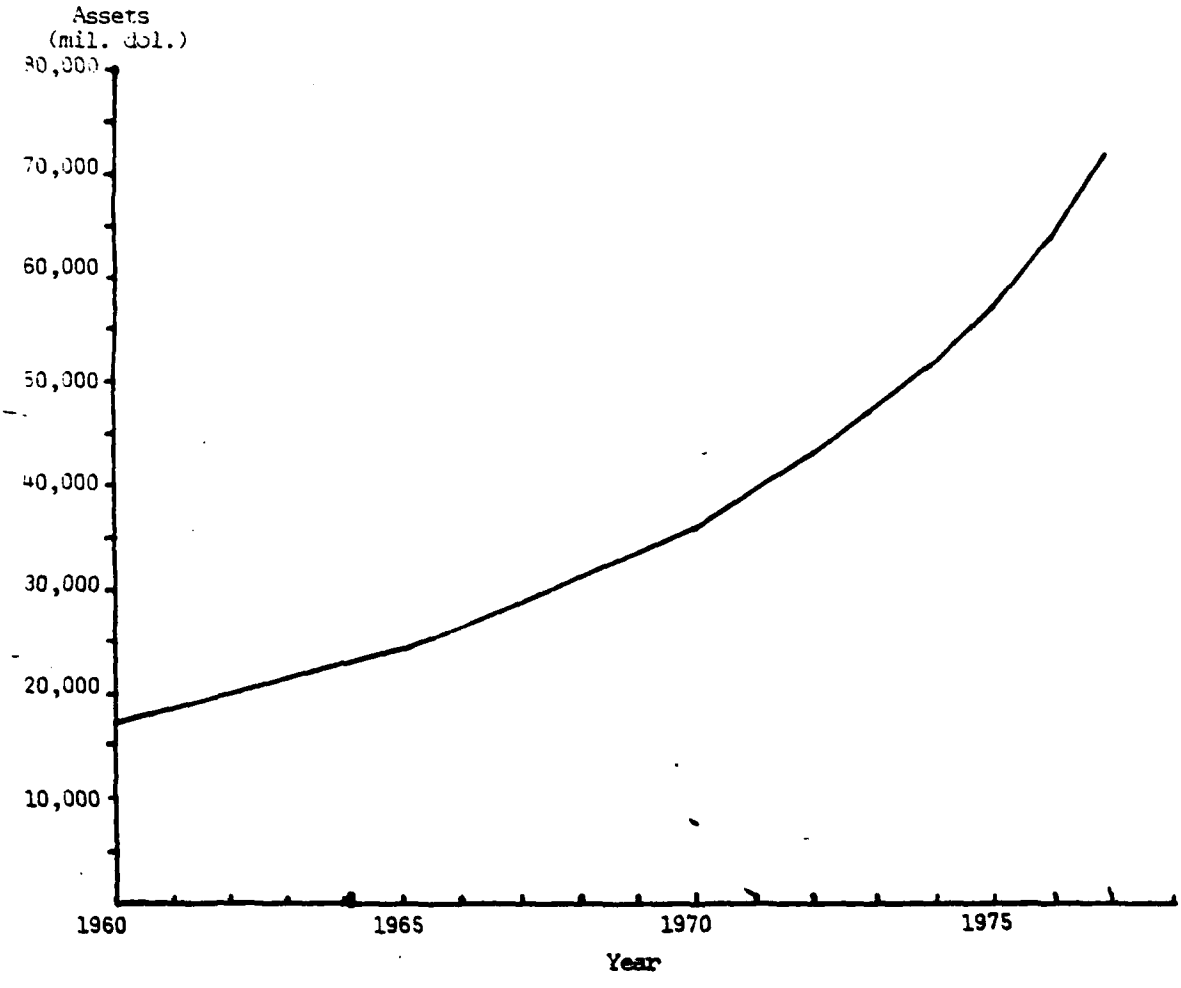

Figure I-1. Assets of all U.S. hospitals from 1960 through 1977

industry and the dollars spent for capital investments (Fig.1-1). Since 1967, the base year for the Consumer Price Index (CPI), health care costs have exceeded the CPI increases each year. As of December 1980 they had reached 266% of the 1967 index and were responsible for the single highest percentage increase of all components of the CPI, which stood at 247%, at that time. In comparison, housing, the second largest incremental component, had increased 263% over the same time period [Ref. 1]. Health care costs have grown from 6.6% of the Gross National Product (GNP) in 1967 to 9.1% of the GNP in 1980. This represents an increase in per capita expenditure increase from 260$ to 863$ or 332% [Ref. 2].

These significant increases in expenditures for health care have been accompanied by larger investments in hospital facilities. For example, the total amount of assets of all hospitals in the United States (U.S.) has increased from approximately 17.7 billion dollars in 1960 to 72.2 billion dollars in 1978 [Ref. 3]. These comments and observations illustrate the importance of the hospital industry in terms of its size and in terms of the rapid rate of increase in the investments for hospital facilities.

B. PROBLEM

Given the absence of proven techniques of analysis noted above, ranking criteria for proposed capital acquisitions

at U. S. Naval Regional Medical Center, San Diego, California (NRMC San Diego) have been derived by committee decision. Through debate and subjective input a committee composed of the major department heads and senior executive personnel integrate previously prioritized departmental requests for equipment purchases. The rank order of acquisitions is determined through the committee members' perceptions of future needs. Tradeoffs for favored programs are common among members. At no time is an explicit comparative analysis conducted of the benefits to be derived from each acquisition. Nor are the benefits of each acquisition ever related to the stated objectives of the medical center. The lack of a common set of criteria to be applied in ranking capital acquisitions makes this entire process extremely subjective.

Upon completion of the prioritization of capital expenditures by the committee, the results are forwarded to the Commanding Officer (CO), NRMC, San Diego, California for approval and submission to the USN's Bureau of Medicine and Surgery (BUMED) for further consideration. Interviews indicate that normally any changes by the C.O. are traditionally relatively minor in nature and inconsequential in the prioritization process.

C. OBJECTIVE OF THE STUDY

The objective of this study is to develop a method of analysis for evaluating proposed expenditures for medical equipment at a NRMC, San Diego. This evaluation is in terms of the contribution that the equipment being considered will make toward the ability of the medical center to provide maximum service to its patients while minimizing the costs of increased services. All medical persons interviewed in connection with this study stated that the maximum service objective is valid.

A significant portion of this study attempts to quantify the expected future service from proposed capital expenditures. This quantification of service is then related to the net cost of the item. This analysis permits the unification of the stated medical center objective of "maximum patient service" provision with the cost evaluation of a proposed capital expenditure.

D. METHODOLOGY

In developing a model for capital expenditure decisions at a NRMC the author utilized three different research techniques:

1. A literature search covering methods of capital expenditure analysis for non-profit organizations;

2. Correspondence and interviews with professional and administrative organizations within the USN's health care community; and

3. A survey of health care personnel to determine weighting factors for the measurement of output. By determining a measure of benefit to be derived from each acquisition and associating with it a net cost, an index of service can be derived which will enable the decision-maker to rank objectively all alternatives as an aid in the decision process.

E. THESIS SUMMARY

In this chapter we have provided a brief summary of the methods currently used in determining capital acquisitions at a NRMC. The importance of rationally analyzing the decisions through the ranking of alternatives, is then discussed.

Chapter II contains an explanation of the capital expenditure philosophy used throughout this study and a background of the capital expenditure analysis currently used at NRMC San Diego.

A development of the cost model to be associated with the input analysis of equipment considered for acquisition is the subject of Chapter III.

Chapter IV involves the determination of an output rating for equipment and includes both qualitative and quantitative aspects.

Once input and output measures have been determined these results are combined in Chapter V to compute an index of service for use in ranking equipment purchase proposals.

In Chapter VI a field survey is conducted at NRMC San Diego applying the model to rank the top five proposals submitted for fiscal year 1982.

Finally, in Chapter VII the author summarizes the thesis and, based on the research findings, makes some recommendations for future condideration.

II. SOURCE OF FUNDS

A. INTRODUCTION

In this chapter the elements of a capital expenditure system are discussed and those elements relevant to this study are identified. Next, the flow of funds from Congressional passage of the Appropriations Bill to NRMC notification of funding authority is briefly detailed. A summary of restrictions imposed by BUMED and their guidance in investment equipment purchases for field activities under their command precedes a short narrative describing the budgeting policy currently in use at NRMC, San Diego.

B. ASPECTS OF A CAPITAL EXPENDITURE SYSTEM

From the financial management literature we find that the components of a capital expenditure system may be categorized as follows: a preliminary consideration and appraisal of projects; the formal request for appropriation of funds; measurement of expenditures against appropriations; and the post-completion audit of results. The preliminary consideration and appraisal of projects should include an analysis of a proposed expenditure to determine the expected contribution of that expenditure toward the objectives of the entity. The formal request for appropriation of funds defines the goals of the command and

capital budgeting philosophy. Capital budgeting is one aspect of a comprehensive budgeting system. The measurement of expenditures against appropriations refers to the process of comparing actual expenditures to budgeted expenditures for a project. This function would be performed as the project expenditures are being made.

The post-completion audit of results includes follow-up techniques to compare the actual benefits from an expenditure with the benefits anticipated in the preliminary consideration and appraisal of projects phase. The post-completion phase of a capital expenditure system would enable a manager to evaluate the ability of various individuals in an organization to project benefits from a capital expenditure and to determine the effectiveness and reliability of the preliminary appraisal of projects phase of a capital expenditure system [Ref. 4].

The purpose of this study is to develop a method of analyzing proposed NRMC expenditures for medical equipment to increase the level of patient care. For this reason, the preliminary consideration and the appraisal of the projects phase of a capital expenditure system will be emphasized.

C. FLOW OF FUNDS

Funding for the purchase of investment items (capital expenditures) originates with the signing by the President

of the appropriation act enacted by Congress. Included in this act is a multiple year appropriation for the part of the United States Navy's (USN) investment program known as Other Procurement Navy (OPN). OPN funds, as defined by the Comptroller of the Navy (NAVCOMPT) and pertaining to a NRMC, are basically any item of equipment costing over $3000 with the exception of vehicles [Ref. 5].

Once this program has been appropriated, an apportionment is determined by the Office of Management and Budget (OMB). The primary purpose of an apportionment is to control the rate at which funds are used. The apportionment by OMB may limit all obligations to be incurred during the period specified or it may limit obligations to be incurred for a specific activity, function, project, object, or a combination thereof. [Ref. 6]

Next OPN funds flow through the Secretary of Defence and Secretary of the Navy. At this level NAVCOMPT allocates these funds to the appropriate operating agencies for the purpose of making allotments. The primary purpose of an allocation is to ensure that the congressional intent is followed for budget activities/programs below the appropriation level.

All OPN funds are allocated to the Office of the Chief of Naval Operations (CNO), which acts as the Responsible Office for these appropriations. The CNO's Comptroller (OP-92) administers the funds and reallocates OPN

funds to the major claimants. The Bureau of Medicine and Surgery (BUMED) is one of the major claimants receiving allocations of OPN funds.

D. MANAGEMENT OF OPN FUNDS AT THE BUREAU OF MEDICINE AND SURGERY

The management of OPN funds at The Bureau of Medicine and Surgery (BUMED) is governed by BUMEDINST 4235.5G of 13 March 1979 (App. A) entitled "PROGRAMMING OF INVESTMENT EQUIPMENT REQUIREMENTS". The intent of this detailed instruction is to establish procedures for programming investment equipment requirements at all BUMED commands, to increase emphasis on the investment equipment program within the Navy Medical Department, and to allow BUMED to perform detailed analysis on the investment equipment in justifying various budget requests and generating short-fused, one time reports in a variety of formats. The Navy Medical Department is defined as BUMED and all its field activities.

BUMEDINST 4235.5G was instrumental in establishing the capital expenditure program currently in use in BUMED. Some of the principal innovations and points are summarized below.

1. Established an equipment replacement program. This program mandated the institution of equipment review committees which develop the command's investment equipment budget or additional (emergency) requirements after the budget submission. The minimum composition of this committee

at a Naval Regional Medical Center (NRMC) shall be: commanding officer, chiefs of services, a representative from each branch clinic, one staff Civil Engineer (CEC) or activity CEC officer, and one biomedical equipment technician. This committee is additionally tasked with conducting a continuing review of each item of investment equipment. This review provides documented evidence of the age and physical condition of all investment equipment. Through this review and Enclosure (1) to the basic instruction, a guide in determining the normal life expectancy of many items of equipment, the committee develops a plan of replacement for capital items for the budget year, the budget year plus one, and the budget year plus two.

2. Emphasis of the review procedures for high cost medical equipment. All requests for medical equipment with a unit or system cost of greater than $200,000 must be accompanied by endorsements from the local Health Systems Agency (HSA) and regional Tri-Service Medical Investment Review Committee.

3. Established costing procedures to be used in justifying acquisition. Enclosure (3) to the basic instruction involves an analysis of life cycle costs to be computed for all investment equipment requested by a command under BUMED. This worksheet is not submitted with the request to BUMED but is retained at the command. In cases where acquisition costs exceed $15,000 (to be raised to

$50,000 by Ref. 7). Enclosure (4), a summary of the costs determined by Enclosure (3), is to be submitted with the request.

4. Established request procedures for certain equipment outside BUMED's pervue. Due to their inherent nature and/or direction from higher authority, certain investment items require approval form other Navy Departments or Agencies although utilized by BUMED activities. BUMEDINST 4235.5G dictates procedures to be followed in requesting investment equipment of this nature. Equipment included in this category are also listed and include;

a. Hospital communications systems and individual equipment items, including radio paging, two way radio, telemetry, nurse call, audiovisual paging, intercom, etc.

b. Microfilm equipment

c. Reprographic (quick copying and duplicating) equipment.

d. Word processing (dictating and automated typing) systems.

e. Filing equipment

f. Automatic data processing equipment including data communications equipment.

g. Diagnostic X-ray systems (less dental).

h. Lease or rental of any equipment, material, or service.

Submission of an annual investment equipment requirement is required by BUMED of all its activities. This letter, which is a priority sequence of investment equipments with appropriate justification requested for the budget year, must be received no later than 15 June of each year. The budget year is defined as the fiscal year following the current year. BUMED also requires submission of an investment equipment budget for the budget year plus one and the budget year plus two. These letters must be received by 15 March of the current fiscal year. When submitting these budgets BUMED activities are reminded that all unfunded budget items for the current fiscal year should be considered cancelled at the time of preparing the budget year submission. This requirement allows proper prioritization of total command requirements. This is not to say that items unfunded at the time of budget submission will not be funded at a later time from the current fiscal year appropriations. It must be remembered that OPN is a multi-year appropriation. BUMED as a major claimant has three years beginning with the budget year in which the appropriation has been granted to obligate these funds.

In fact supplemental augmentations are common in BUMED's funding of investment equipment. For example in FY81 which has two years remaining for the obligating of funds, supplemental grants have accounted for 48.8 percent or $996,000 of the total grant awarded NRMC San Diego as of 30

September 1981 [Ref. 8]. Additionally, after the three year obligation period for OPN funding has expired, activities have two years in which to close their accounts.

Upon receipt of budget year requests from all activities and authorization to obligate funds from CNO (OP-92), BUMED apportions funds using a predetermined formula. In FY81 the method used to determine resource allocations was based on the total inventory dollar value of the Navy Medical Department and the inventory dollar value reported by each field activity; i.e. the ratio of the field activities inventory dollar value to the total medical department inventory dollar value, multiplied by the total resources initially made available yielded each activities initial funding level [Ref. 9]. It must be remembered that because of the apportionment process at OMB the initial outlay of OPN funds is only a fraction of the total congressionally approved apportionment.

Inventory values are determined by the different activities investment equipment inventory reports, a required quarterly submission from each activities equipment review committee. For example, the OPN initial budget for NRMC San Diego for the past three fiscal years has ranged from 12-14 per cent of the total BUMED apportionment [Ref. 10].

E. OPN BUDGETING AT NRMC SAN DIEGO

As previously mentioned the determination of investment equipment items and their prioritized ranking is done in a meeting of the NRMC Investment Equipment Review Committee. Although this committee or its members are not designated in writing, the author found that, because of its important purpose of allocating scarce resources, its existence was widely known and membership considered exalted positions. The following officers are current members of the Committee:

Commanding Officer, NRMC San Diego (Chairman)
Commanding Officer, Naval Regional Health Care Center
Director of Clinical Services, NRMC San Diego
Director of Administrative Services, NRMC San Diego
Heads of all Medical Services Department, NRMC San Diego (26)
Public Works Officer, NRMC San Diego
Comptroller, NRMC San Diego
Officer in Charge Branch Clinic NAS North Island
Officer in Charge Branch Clinic NAS Miramar
Officer in Charge Branch Clinic NAVPHIBASE Coronado
Officer in Charge Branch Clinic NAVSTA San Diego
Officer in Charge Branch Clinic NOSC San Diego
Officer in Charge Branch Clinic NSC San Diego
Officer in Charge Annex NTC San Diego
Officer in Charge Branch Clinic FLTASWSCOL San Diego
Officer in Charge Branch Clinic NAVCOMMSTA San Diego
Officer in Charge Branch Clinic MCRD San Diego
Officer in Charge Branch Clinic NAF El Centro

The total number of members of this board has varied between 31 and 35. The fluctuation is caused by individuals holding two or more of the above positions [Ref. 11]. A biomedical equipment technician also sits on the committee as a consultant on equipment maintenance costs, reliability, repair parts availability, etc.

In approximately mid January of each year the Committee is advised of a meeting to be held in March and agenda items for that meeting. Attendance is required for all those members who have submitted investment equipment items for inclusion in the budget year transmittal letter. This meeting is convened over several days and does not dismiss until all items have been put in rank order. All items requested in previous years must be included in this ranking if they have not yet been funded. To remove an item once it has been submitted requires separate correspondence and BUMED approval. Requested items are classified into two categories: those deemed essential and requiring only relative ranking by the Committee and those items not essential at the moment. Prior determination by the Commanding Officer, NRMC San Diego is the criteria used in classifying equipment into each of these categories. In ranking investment equipment items the OPN Equipment Budget Item Justification Worksheet (Encl (3) to App. A) is the basic document used in determining cost. Need and the sponsor's ability to transmit that need to the committee and the chairman are the most important factors in ranking. Cost is considered to a lesser degree. Interviews indicate that those items whose life cycle costs are lower within each category generally receive more favorable consideration.

Thus, the whole ranking procedure is very subjective. Costs are determined precisely but, as will be

shown later, the basis for these costs is somewhat less than precise. No attempt to quantify the benefits to be derived is ever attempted. Only in the remarks section of the OPN Equipment Budget Item Justification Worksheet is there a reference made to benefits to be derived from a particular equipment purchase.

F. SUMMARY

This chapter was intended to impart to the reader a basic knowledge of the components of a capital expenditure system as applicable to this study. Once the objectives have been defined the actual processes involved in authorizing funds for expenditure on capital investments at the NRMC level was examined. These processes included both the actual flow of funds down to the NRMC level and the decision process conducted at that level in determining priorities for capital investment spending.

III. INPUT ANALYSIS OF EQUIPMENT

A. INTRODUCTION

The purpose of the input analysis is to determine the net investment or outlay which would be required if an equipment request were to be approved. A technical approach to this analysis, and the method to be used by the author is this study is called benefit/cost analysis. The underlying concept is that an investment should only be undertaken if its benefits exceed its costs and the approach therefore involves an attempt to measure both benefits and costs.

The idea of comparing the benefits of a proposed course of action with its cost is not new. Techniques for analyzing the profitability of proposed business investments have been in vogue in private industry for many years. Certain government agencies, such as the Bureau of Reclamation, have made such analysis for decades. With the advent of the Planning Programming Budgeting System (PPBS) in the Department of Defense (DOD) in the 1950's it became fashionable to apply benefit/cost analysis to all sorts of proposed programs in public sector nonprofit organizations. However the results of these efforts have been mixed, and there is now considerable controversy about the merits of the whole approach. Nevertheless, benefit/cost analysis has

undoubtedly produced results. There are two essential points to be made:

1. Benefit/cost analysis focuses on those consequences of a proposal which can be estimated in quantitative terms. Since there are few important problem in which all the relevant factors can be reduced to numbers, benefit/cost analysis generally will not provide the complete answer to any important problems.
2. However, if some of the important factors can be reduced to quantitative terms, it is often better to do so than not. The resulting analysis narrows the area within which management judgement is required, even though it does not eliminate the need for subjective value judgement. [Ref. 12].

From the above it can be easily seen that the analysis of costs is an essential element of any benefit/cost analysis. The purpose of this chapter is to determine the net investment which would be required if a proposed equipment investment was undertaken.

B. FULL-COST VERSUS INCREMENTAL COST ANALYSIS

An input analysis can be developed by using a full-cost or an incremental cost approach. The approach selected should provide the decision-maker with relevant information, and the analysis should provide a consistent ranking of the alternatives.

Full-costing or absorption costing analysis would include all costs of a project. Those costs could be subdivided into direct and indirect. Direct costs would include those expenses that can be directly associated with a project. Indirect costs are those incurred for the benefit of more

than one project or activity an they must be appropriately allocated to those projects. Expenses of this type include such items as supervisory salaries, utilities, insurance and taxes. Since these expenses connot be assigned directly to a project, they are allocated to all the projects benefiting from the expense incurred, in a full-cost analysis. [Ref. 13].

Incremental or differential costs analysis would include all future costs that would be different because of the decision to purchase new equipment. For example, if new equipment was being considered for the surgery department the appropriate types of operating costs would be the same as mentioned above in the full-cost analysis discussion. However, these costs would be included in the analysis only if they will change as a result of a decision to purchase the equipment. As an example, salary costs would be included in an incremental analysis only if additional costs were incurred because of the equipment purchase. [Ref. 14].

A simple example of the use of full-cost or incremental cost analysis for operating costs is contained in Figure III-1.

	Full-Cost Analysis	Incremental-cost Analysis
Operating expenses:		
Salaries	$1950	---
Fringe benefits	269	---

Maintenance costs	300	$300
Supplies	225	225
Power	180	180
Other Utilities	30	---
Floor space	120	---
Other costs	360	---
	$3435	$705

Figure III-1 Full-cost versus incremental operating costs

The example above refers to annual operating costs for a hypothetical proposed item of equipment. The estimates are $3,435 for the full-cost analysis and $705 for the incremental-cost analysis. The difference in the two approaches is in the treatment of the salaries and fringe benefits which are direct costs, and the other utilities, floor space, and other costs which are indirect costs.

The assumption regarding the salary and fringe benefit costs is that an existing employee or user presently has idle time which can be utilized if the equipment is purchased. The salary charge, in the full-cost analysis, represents an allocation of the operator's salary for the estimated time required to operate the equipment. The fringe benfit item is an allocation of the employer's share of social security

taxes, state and federal unemployment taxes, pension payments and other insurance benfits.

Because of the assumption that the employee has idle time, there is no charge in the incremental cost analysis for salaries or fringe beneifits. The justification is that these costs will not change in the future if the proposed equipment is purchased and therefore should not be included in an incremental analysis.

The utilities, floor, space and other cost items are considered to be indirect. That is, these costs are incurred for the benefit of more than one project. Therefore, the full-cost analysis includes an allocation of these costs to all projects that will benefit from their incurrence. These indirect costs are not included in the incremental analysis because they are not expected to change in the future if a decision is made to purchase the equipment. The estimated costs of $705 in the incremental analysis, therefore, represent the only additional future operating costs that would be generated by the purchase of the new equipment.

The next consideration then, would be, should analysis procedures for medical center equipment involve the use of full-cost or incremental cost analysis? The cost items included in this analysis are estimates of what will occur in the future. These estimates of the future should include only relevant cost data. In deciding among alternatives, many leading authorities state that relevant costs are those

that will be different under one alternative from what they will be under the others. [Ref. 15]. Therefore, incremental cost analysis (differential costs) will be used in the remainder of this study.

Two factors are important, therefore, in the determination of relevant cost data. The first factor is that all cost data should pertain to future costs. The second factor is that only those cost items that will be changed because of the alternative being considered should be included in the analysis.

C. WEAKNESSES INHERENT IN BUREAU OF MEDICINE INSTRUCTION 4235.5G

Before going any further it is necessary to point out other noted deficiencies in the current BUMED guidance for cost determination in proposed investment equipment acquisitions. These deficiencies were identified by the author in researching the costs used in completing the BUMED Other Procurement Navy (OPN) Equipment Budget Item Justification Worksheet and in interviews with hospital administrators.

An often voiced complaint was the lack of clarity and the seemingly irrelevance of many items on the Worksheet. It must be remembered that this is a BUMED directive and it is prepared for their own purposes. To incorporate this Worksheet in its entirety as a Naval Regional Medical Center

(NRMC) directive to be used in determining local priorities for investment equipment is asking the chiefs of service to do more than what is necessary. This Worksheet is intended for BUMED use in justifying purchases to DOD and Congress. The detailed information requested for that purpose is not necessary at the NRMC decision-making level. Additionally, chiefs of service stated they are not trained, nor do they have the time or manpower, to complete the cost analysis of the Worksheet [Ref. 16]. In reality interviews indicated that most of these figures are obtained from the product salesman, a violation of the basic instruction requiring in-house or Navy staff studies and surveys in support of systems and equipment requests.

In detailing costs the time value of money is ignored by the BUMED directive. This directive states in enclosure (4) that the concept of the present dollar value of future outflows is not taken into account since it assists neither BUMED nor the command in its analysis of life cycle costs. This assumption is fallacious in that the supplies and annual maintenance costs often exceed the acquisition cost of medical equipment. To award these future outflows full value in the present time analysis distorts the life cycle costs and heavily biases the analysis against the equipment purchases. The same point can be made for the inclusion of the one time disposal cost or salvage value of the equipment. This is a return of funds several years in the future for the

sale of the equipment at the end of its service life. To include those funds in the present analysis at their future value misrepresents the salvage value and lowers the life cycle costs biasing the analysis in favor of the equipment purchase.

The Worksheet was not intended purely as a cost-analysis determination. It is a justification worksheet. The inclusion of subjective questions with "yes" and "no" answers without assigning costs was argued by the chiefs of service as unfair. For example, questions regarding the population base served and the effect on anticipated workload, although not assigned a value, imply imputed costs. Imputed costs are hypothetical costs representing the cost or value of a resource measured by its use value. Imputed costs do not involve actual cash outlays and are not considered in accounting cost calculations [Ref. 17]. To assign a decreasing workload to a proposed equipment purchase attaches to it a stigma at budgeting time because it is viewed as decreasingly important by other chiefs of service. In actuality it might be considerably more efficient than present techniques thereby freeing resouces for other uses.

In summary, the disadvantages then are the length and irrelevant detail of the Justification Worksheet of BUMEDINST 4235.5G. Although this information is required by BUMED it is not necessary at the NRMC level for decision-making in ranking priorities. The Life Cycle Cost Analysis Worksheet

is viewed by NRMC administrators as too simplistic in its assumptions. To ignore the time value of money is not realistic in this age particularly when one observes the workings of budgetary regulatory agencies. Therefore, all estimates of cash outflow should be time-adjusted to a common point of time before they are added together. For purposes of this study, all cash outflows will be time-adjusted to the point of the initial outlay for the investment. Current outlays will then be stated at 100 per cent, and all estimates of future outflows will be time-adjusted to the point of the current outlay. For the remainder of this study, future outlays will be discounted at ten per cent per annum as per the DOD Cost Comparison Handbook [Ref. 18].

D. DETERMINATION OF NET COST

There are three computations involved in the input analysis for new equipment. These computations are incremental acquisition cost, incremental operating cost, and net outlay cost. The remainder of this chapter will discuss the way in which these costs are determined.

1. Incremental Acquisition Cost

The first part of the input analysis involves the determination of the incremental acquisition cost. It follows from the discussion of relevant cost date above that only future costs which will be different should be included in the computation of incremental acquisition cost. When

discussing the following sections, reference should be made to Appendix B of this thesis in order to identify each item of the input analysis.

The original invoice cost is easily determined from the vendor's invoice. In most cases this includes the equipment transportation cost. Should that not be the case and the purchaser is required to pay the transportation cost as a separate item, it should be included under this cost category. Therefore, transportation cost may either appear as a portion of the original invoice cost or as a separate charge.

Installation costs would include expenditures for utility connections, rearrangement of the room dividers and the reinforcement of the building structure. These costs as defined by BUMEDINST 4235.5G are to be borne by Operations and Maintenance, Navy (O & M N) funds. Again, in many cases some of these costs are included in the acquisition cost and are paid by the vendor.

An item easily overlooked in analysis of this type is additional working capital requirements. Typically this item would include additional investments in accounts receivables, inventories, and prepaid expenses. If additional liabilities, such as accounts payable, will be incurred because of the added investment in assets, these liabilities should be deducted from the assets. Therefore, the additional investment in working capital which will be

required for the operation of the new equipment should be included in the analysis. Training costs if they are to be a one-time initial expense should also be included in acquisition costs.

The items discussed above, original invoice cost, transportation cost, installation cost, additional working capital, and training costs, should be added together to determine the total of the original outlay cost.

All proceeds from the retirement of assets which will be made possible because of the new equipment purchase should be deducted from the toal outlay cost. Examples of possible asset retirements would include the sale of existing equipment which would no longer be needed if the new equipment is purchased, and a reduced investment in supplies inventory made possible by the utilization of new equipment. The total proceeds from assets released because of the proposed equipment should then be deducted from the total outlay cost to arrive at the new incremental acquisition cost.

The amount of funds that will be released at the end of the proposed equipment's life should be estimated. This would include the salvage value of equipment and working capital released by the sale of the equipment. This estimate of funds released should be time-adjusted as illustrated below reflect the present value of these estimated future dollars.

1.	Estimated salvage value of the proposed equipment (in five years)	$200,000
2.	Estimated working capital released when the proposed equipment is retired	26,000
3.	Total funds released at the end of the economic life of the proposed equipment	226,000
4.	Time adjustment factor of 10% in five years	.621
5.	Present value of investment released in five years	140,346

Reference was made in the time-adjustment of cash outlays that the economic life of equipment should be estimated. The determination of this estimate involves a consideration of obsolescence, physical life, and maintenance policy for the equipment. Enclosure (1) of Appendix A to this thesis should be used as a guide in determining economic life of equipment but should not be the sole criteria. In the medical field equipment obsolescence is the primary consideration and expected future developments should be determined. An estimate of the economic life of the equipment is also necessary in order to project life cycle operating expenses associated with the equipment.

2. Incremental Operating Cost

The second part of the input analysis involves a computation of the incremental operating cost. Operating costs are included in the analysis because of their importance to an equipment decision. For example, in many cases operating costs exceed the original outlay cost for equipment. [Ref. 19]. Many of those interviewed by the author indicated that the significant expenses in medical services, particularly in the x-ray field requiring the use of specialized equipment are the costs of personnel and supplies for operation. In many hospitals the idle time of equipment is insignificant in comparison with the idle time of highly paid professional personnel. [Ref. 20]. These comments serve to illustrate the importance of including operating costs in the analysis for proposed equipment.

The incremental operating cost should be determined on a per annum basis for the economic life of the equipment. The annual incremental operating costs should then be time-adjusted in the same manner and for the same reasons as were given in the earlier discussion. Training of medical personnel to operate new equipment may be included either as a one time acquisition cost or as an annual operating cost. In some cases this expense is included in the purchase price of the equipment. If training costs are annual expenses, they must be recorded in this portion of the analysis.

Additional salary costs incurred because of the decision to purchase equipment should be determined. Fringe benefits associated with the additional salary costs can be computed from the Cost Comparison Handbook. [Ref. 21]. The current directive calls for a figure of 20.4 per cent to be used in calculating retirement benefits of federal employees. Other figures mandated for determining fringe benefits are 3.7 per cent for federal employee insurance (life and health) benefits and 1.9 per cent for employee workmen's compensation, bonuses and awards, and unemployment programs. In the author's analysis an average cost derived from the ratio of fringe benefit costs to total salary costs will be used.

Maintenance costs are determined from equipment maintenance records of similar equipment and manufacturer's estimates. Consumable supplies cost is based on projected usage rate. This figure is obtained from the Justification Worksheet. Power and utilities figures cannot be determined for individual pieces of equipment. Here, the analysis relies on the manufacturer's estimates. Floor space costs should be included in the analysis if the new equipment will affect the total outlay made for space costs, or if there is another valuable use for the space required by the new equipment. In most cases equipment proposals are for replacement equipment and this figure is irrelevant and can be disregarded. The

form for the computation of incremental operating cost per annum is presented in Appendix B to this study.

3. Computation of Net Outlay Cost

The purpose of this section of the analysis is to bring together the various factors discussed previously; net incremental acquisition cost and incremental operating cost of equipment. The net incremental acquisition cost which was discussed in the first part of the input analysis should be included in the computation. Next, the incremental operating cost per annum, the second item discussed in the input analysis, should be included in the computations of the net outlay cost. These incremental operating costs should then be time-adjusted. The time-adjustment technique previously illustrated in connection with the salvage value of the proposed equipment. It is assumed for the purposes of time-adjustment that the cash flow occurs at the same time that the costs are recognized.

If these estimated costs are uniform throughout the life of the equipment, they can be time-adjusted by applying one present value factor. If the estimated costs vary each year, then each year they will have to be time-adjusted individually.

a. Estimated annual incremental operating costs are uniform (3 years):

Estimated costs per annum	$26,000
Time-adjusted factor	2.487

Time-adjusted incremental operating costs over the lifetime of the equipment	$64,662

b. Estimated annual incremental operating costs are not uniform (3 years):

	1st yr.	2nd yr.	3rd yr.
Estimated costs per annum	$26,000	$28,600	$31,460
Time adjustment factor	0.909	0.827	0.751
Time-adjusted incremental operating costs over the lifetime of the equipment	$23,634	$23,652	$23,626
Total time-adjusted incremental operating costs over the lifetime of the equipment.			$70,912

Figure III-2 Illustration of two methods of time-adjusting incremental operating costs.

The time-adjustment factors used in Figure III-2 assume a discount rate of ten per cent compounded annually. In part one the operating cost is assumed to be constant for a hypothetical piece of equipment over the estimated three year lifetime of that equipment. In part two the operating costs are assumed to increase annually at a rate of ten per cent over the three year lifetime of that equipment. The time-adjusted technique used in part one of Figure III-2 for uniform costs is an annuity method. An annuity may be defined as equal installments over equal periods of time. [Ref. 22].

The individual time-adjustment factors, used in part two of Figure III-2 where annual costs are not uniform, are

related to the time-adjustment factor that was used for uniform costs. The total of the three time-adjustment factors used where annual costs are not uniform (0.909 + 0.827 + 0.751 = 2.487) is equal to the time-adjustment factor used for uniform annual costs (2.487).

For the remainder of this study the particular method that is applicable to the individual piece of equipment being analyzed will be applied. Figure III-3 below is an example of the computation of net outlay cost. The figures used are those determined for the purchase of a computed tomographic scanner, the top priority item requested by NRMC San Diego in their FY 82 investment equipment budget request. These figures can also be found in Appendix D.

a. Incremental Acquisition Cost Original invoice cost	$1,395,000
Transportation cost (included above)	0
Installation cost	83,000
Training cost	80,000
Additional working capital	25,000
Total initial outlay	$1,583,000
Less salvage value of assets released because of the equipment	0
Less the present value of salvage value and net working capital released at the end of equipment's economic life	340,342
Incremental acquisition cost	$1,242,658

b.	Incremental Operating Cost Per Annum	
	Training requirements	0
	Salaries	24,500
	Fringe benefits	6,370
	Maintenance	80,000
	Supplies	26,000
	Power	4,000
	Other utilities	0
	Floor space	0
	Insurance	0
	Other specify	0
	Total operating cost per annum	$140,870
c.	Computation of Net Outlay Cost	
	Net incremental acquisition cost	$1,242,658
	Total operating cost per annum	140,870
	Time adjustment factor	3,791
	Time adjusted incremental operating cost for the estimated equipment life	534,038
	Total outlay cost	$1,776,696

Figure III-3. A computation of net outlay cost

The individual costs used in Figure III-3 were determined from the manufacturer's estimate, equipment repair records and departmental personnel requirement estimates. In determining salvage value the straight-line method of depreciation was used. This is the method currently in use at NRMC San Diego. Enclosure (1) to Appendix A estimates

eight years as the economic life of a tomographic scanner. Projected advances in medical technology suggest this equipment will be obsolete in five years. Five years was used as the estimated life while the equipment was depreciated over eight years to determine salvage value. Again, ten percent was used as the discount rate in projecting present value of the salvage value of equipment and working capital released. All methods used were those currently in use or coming into use at NRMC San Diego. They will remain consistent throughout the remainder of the study.

In benefit/cost analysis in all profit and in many non-profit enterprises there is one more point to be considered when computing net outlay cost. That is, the anticipated annual revenue received from the use of the proposed equipment. Normally this revenue would be time-adjusted over the lifetime of the equipment and deducted from the net outlay cost to determine the actual cost. In this case revenue is not a consideration. For these patients whom the NRMC serves there is no revenue associated with the use of the equipment. In some instances outside agencies, such as local community hospitals and other NRMC's will use NRMC San Diego's equipment or facilities. However, these dealings result in reciprocity of services in almost every instance and there is no exchange of funds. Since no monetary value can be easily attached to these mutual

services, there is no revenue received. The net outlay cost, then, is the cost of the equipment.

E. SUMMARY

The input analysis developed in this chapter is a determination of all relevant costs which would be incurred if a proposed piece of equipment were to be purchased. All these costs are incremental in that they would accrue only if the equipment was actually bought, installed and operated. Although most of these costs are considered and included in the OPN Equipment Budget Item Justification Worksheet of BUMEDINST 4235.5G this cost analysis was considered necessary for several reasons. The complexity and intermingling of subjective with actual costs in the BUMED directive have lessened its value to those decision-makers at the NRMC level. The same argument can be applied to the applicability of many of the required calculations. The disregard of the time value of money when considering future operating costs and salvage value was determined to be an erroneous and fallacious assumption. And finally, the expenditure of resources required in many instances to obtain the depth and accuracy of requested information resulted in incomplete and less than accurate figures.

IV. OUTPUT ANALYSIS OF EQUIPMENT

A. INTRODUCTION

There are two aspects of the author's analysis: quantity of output and quality of output. The first item pertains to the volume of service rendered and the second item pertains to the nature and importance of the service rendered. In this chapter these two factors will be discussed and criteria for their measurement determined and weighted accordingly.

B. QUANTITATIVE ASPECTS OF THE MEASUREMENT OF OUTPUT

One of the assumptions of this study is that the objective of a hospital is to provide service to its patients. Although objectives were not documented by Naval Regional Medical Center (NRMC) San Diego directive, all medical center personnel interviewed agreed "that the objective of a NRMC is to provide maximum service to its patients with a limited amount of funds in the long run." Therefore, in order to determine how well the proposed equipment will contribute to this hospital objective, it is necessary to measure (estimate) the amount of service that the equipment will provide. The purpose of this "output analysis" section of this thesis is to develop a method of measuring the estimated service that will be provided by equipment.

Another assumption of this study is that dollars taken in as revenue are generally used as a measure of service for profit-seeking enterprises. For this reason, traditional rate-of-return analysis generally uses dollars of revenue as a measure of output in new equipment analysis. Revenue cannot be used as an output measure for a NRMC because, as previously discussed, it is insignificant and incident to it's principal role.

The author, through a literature search, found three units that were commonly used to measure the quantity of output for hospital and medical centers in capital budgeting patient days, hours of use, and patients served (occasions of service). The patient days and hours of use measurement units are time related in that time is the unit of measure. The patients served indicator would record the frequency and number of services provided by the equipment.

The requirements of a measurement unit of service are that the unit of measurement should be a valid indicator of the service provided, and that the unit of measurement can be used as a common denominator for the inter-ranking of requests from the various special professional service departments [Ref. 23]. It would seem logical to the author that either hours of use or patients served could be used as a reasonable indicator of the service provided. Patient days would require apportionment of that unit of measure over

various services and equipments, a computation for which data is not available.

Patients served (occasions of service) could be used as an indicator of service provided within a department; however, it has limitations as a common denominator for the inter-ranking of requests among the various departments. For example, within the surgery department there is major and minor surgery. There is some disagreement among medical personnel about what constitutes major surgery and what constitutes minor surgery. It has been suggested that three minor surgeries are comparable to one major surgery [Ref. 24]. However, there is no general agreement on the relationship. Therefore, the use of patients serviced as an indicator of output has limitations within a department because of the lack of comparability between variation in components of occasions of service. This limitation of the patients served criterion also applies to the various laboratory departments and the delivery department.

Another problem associated with the use of the patients served criterion as a measure of output is the inter-ranking of requests from various departments. The purpose of this analysis is to compute an index of service for each equipment request from all professional service departments by dividing the estimated output by the estimated input (benefit/cost). The result will represent the estimated output rating per dollar of net cost. The requests from all

departments will then be ranked from highest service per dollar of net cost to the lowest service per dollar of net cost. The inputs, discussed in the preceding chapter, are all stated in dollars which represent a comparable unit of measurement. It is also necessary that the unit of measurement used to compute output have comparability within a department and among the various departments.

What, then, should be the relationship between the number of deliveries performed by the labor and delivery personnel and the number of operations performed by the surgery department? Or, what is the relative relationship between the number of operations performed by the surgery department and the number of tests performed by the pathological laboratory? The results obtained from interviews with medical personnel indicate that there is no general agreement as to what constitutes a satisfactory answer to these questions. Because of the limitations of the patients served criterion discussed above, lack of comparability in measuring the output within a department, and lack of comparability in measuring the output among the various departments, this criterion was rejected as a possible method of measuring the quantity of service provided by equipment.

The other criterion suggested as a measurement unit is hours of use. This criterion relates to the utilization of the equipment. The use of this criterion for measurement

will be evaluated from the standpoint of comparability within a department and among various departments.

The use of this "time" criterion assumes that time or utilization is a good indicator of the quantity of output for a department or function and the problems associated with the measurement of output for a piece of equipment. For example, to determine the total output of a department, it would be necessary to evaluate and weigh the relative use of all the factors, such as personnel, supplies and equipment [Ref. 26]. On the other hand, a reasonable indicator of the output of equipment would be the relative use of this equipment. For these reasons, the "time" criterion has been selected as a unit for measuring the output of equipment for the analysis. The following discussion pertains to the implementation of this time criterion as a unit of mesaurement.

An estimate should be made to determine the expected utilization of the proposed equipment. The following procedure will be followed in this study. First, it should be determined how long it will take to render one occasion of service. For example, an item of equipment for use in surgery might require two hours for the occasion of service. This two hour estimate should include clean-up time and preparation for the next use. It would then be theoretically possible to perform 12 occasions of service a day if the equipment were utilized 100 per cent of the time. The number of occasions of service that are expected to be performed a

day should then be determined. The estimated number of occasions of service should then be multiplied by the time required to perform one occasion of service in order to determine the total expected hours of utilization a day. The total expected hours of utilization will then be divided by 24 hours in order to determine the expected percentage utilization a day.

The denominator of 24 hours was chosen above because practically all medical center facilities are on at least a standby basis, for 24 hours a day. The use of a 24 hour base for all departments has the advantage of inter-departmental comparability.

C. QUALITATIVE ASPECTS OF THE MEASUREMENT OF OUTPUT

Considerable emphasis was placed on the qualitative aspect of output during the course of this analysis. The area was discussed thoroughly with hospital administrators and medical personnel in order to determine what qualitative factors, if any, were deemed important. In addition to this procedure, OPN Equipment Budget Item Justification Worksheets were examined. These worksheets were examined for the purpose of determining the justifications that were given to support requests for new equipment. From these studies, the following list of qualitative items was derived. Will the equipment:

1. provide capability to save patient lives that otherwise would not have been saved?
2. perform a service that is not presently available?
3. improve utilization of other hospital services that are already available?
4. provide greater comfort to the patient?
5. provide a more uniform test or service than the method currently in use?
6. provide greater safety to the patient?
7. provide greater dependability of service to the patient?
8. permit a more timely completion of service?
9. permit a better diagnosis and evaluation of patient needs?

These nine qualitative items were incorporated into a survey which was distributed to 35 chiefs of service on the Investment Equipment Review Committee at NRMC San Diego. Also included on the survey was the qualitative question: How much consideration should be given to the expected utilization time of the equipment? This question was included in the survey for the purpose of determining weighting relative to the qualitative factors.

The surveys (Appendix C) were distributed with instructions to allocate a total of 100 points to the ten questions. There were no restrictions imposed and cost of equipment was not to be considered a factor in determining allocation. Interpretation of each question was left up to the individual completing the survey. Some of these different interpretations are discussed in a later section.

Of the 35 surveys distributed to the chiefs of service, 28 were returned. Points were then summed for each question of the 28 returned surveys and the results are as depicted in

Figure IV-1. For the last question on the survey, "Other Considerations," cost was most often cited as an additional criterion for investment equipment decisions. This was not considered relevant in the output analysis, as cost is the determining factor of the input analysis. As can be seen from Figure IV-1, questions one, two, eight and ten were major considerations in the new equipment decision. These questions relating to utilization, life-saving potential, dependability of service, and diagnosis and evaluation of patient needs gathered 1564.5 of 2800 possible total points, representing 55.9 per cent. No other question had as much as eight per cent of the total. For that reason those four are considered primary in the investment equipment decision and will be quantified in the output analysis in this study. The expected utilization of equipment factor was discussed under quantity of service. The following discussion pertains to the weightings to be assigned to the remaining three qualitative factors that were discussed above.

	Total Points	Total Per Cent
1. Expected utilization time of the equipment	358	12.8%
2. Ability to save patient lives that otherwise would not have been saved	432.5	15.5%
3. Performance of a service that is not presently available	193	7.0%

4.	Improve utilization of other hospital services that are already available	175	6.3%
5.	Provide greater comfort to the patient	129	4.6%
6.	Provide a more uniform test or service than the method currently in use	207	7.4%
7.	Provide greater safety to the patient	217	7.8%
8.	Provide greater dependability of service to the patient	355	12.7%
9.	Permit a more timely completion of service	206.5	7.4%
10.	Permit a better diagnosis and evaluation of patient needs	419	15.0%
11.	Other considerations	108	3.5%
	Total	2800	100.0%

Figure IV-1. Results of survey for criterial considered in investment equipment expenditure decisions.

The approach that is discussed in this study for assigning a range of weightings to the four primary factors could be applied to any of the other seven quantitative factors. This determination would depend upon the relative importance placed upon these factors by a particular NRMC or hospital. The illustration in this study is based on one quantitative and three qualitative factors because field survey results indicated that these indeed were the major considerations.

The results of interviews with hospital administrators and medical personnel at NRMC San Diego concerning their previous commands indicate that some NRMCs consider only the

utilization factor in making equipment decisions of this type. On the other extreme, some of those interviewed indicated that greater emphasis was placed on life-saving potential at previous commands. One reason given for the different emphasis on these factors is the frequent inverse relationship between utilization and life-saving potential. This is true because in many cases equipment that will be of direct benfit in the saving of patient lives, such as an artificial kidney, will frequently have a very low utilization. Therefore, the acquisition of life-saving equipment in these instances will result in low utilization rates.

The following approach was taken in determining the relative importance of the four factors. From review of maintenance records of similar equipment or equipment being replaced, an average utilization was determined. Then, consideration was given to the desired utilization level for these types of equipment. The actual results from the study could then be modified to reflect the desired usage level when it is different from the actual. The results derived from this procedure can then be stated in terms of an average percentage utilization for all service department equipment for the NRMC. This average utilization will serve as the basis for assigning the relative rankings. Assume that the NRMC has decided that a 25 per cent utilization is desirable. Then, if the Investment Equipment Review Committee provides

for equal emphasis on all four factors (utilization, life-saving potential, dependability of service, and better diagnosis and evaluation), the normal weighting assigned to these factors would be 25 per cent, 25 per cent, and 25 per cent, respectively. There could, of course, be any combination of weightings assigned to these factors.

The normal utilization of equipment for special service departments varies between 15 per cent and 38 per cent, as determined from equipment maintenance records. The following comment indicated the nature of equipment utilization for these departments:

> ... idle equipment is the unavoidable accompaniment of 24 hour per day availablility of equipment whose use is determined by events wholly beyond the control of the hospital management that provides such equipment. [Ref. 27]

Kelly stated in his case study that utilization for these types of equipment varied from 14 per cent to 38 per cent [Ref. 28]. This finding of 40 years ago is almost identical to the author's review of the selected equipment mentioned above.

The next consideration is to analyze the life-saving potential factor to determine an approach for weighting the qualitative item. Only equipment that will be of direct benefit in saving lives should be given a weighting under this factor. Many items of equipment might have an indirect bearing on saving lives. For example, a new type of sterilization equipment might do a more effective job of

sterilization of instruments in the operating room. It could be argued, with some merit, that this new sterilization process would permit the saving of patient lives. This life-saving potential would be very indirect.

It is the author's intention to include only items that would enable a hospital to save a patient's life that could not be saved by the hospital if the equipment were not purchased. Examples of this type of equipment would be cancer-treating radiation machines, artificial organs, pacemakers, and heart resuscitators.

The various types of patients whose lives might be saved by the equipment should be determined. One type of patient whose life could be saved by the equipment might be one with a terminal illness. It might be possible to extend his or her life; however, he or she would undergo a great deal of suffering for that extended period. This situation could be referred to as life extension rather than life saving. Another possibility would be a pediatric patient. The saving of this life could result in the adding of 70 or more years to the life of a productive member of society.

The various types of life-saving could be weighted differently in the analysis. Or, some types of life-saving potential might not be given any weighting. The following discussion assumes that all types of life-saving potential have been weighted equally.

Next, it should be determined how to weight the potential life-saving factor on a per-life basis. It was indicated earlier, for discussion purposes, that a normal utilization of 25 per cent had been decided upon. It was further assumed that the life-saving potential was given an equal weighting with the utilization factor. The next consideration is to determine how many potential lives are comparable to the desired utilization of 25 per cent. It is assumed for purposes of this discussion that a piece of equipment that will save five lives should be weighted equally with equipment that will be utilized 25 per cent of the time with no life-saving potential, ceteris paribus therefore, equipment with a life-saving potential of four lives would receive a weighting of 20 per cent (4/5 x .25) for the life-saving factor.

The "dependability of service" factor should then be considered for the purpose of determining the importance of this factor in relation to the utilization and life-saving factors. The first consideration is to determine the nature of items which will be considered under the dependability of service criterion. It is intended that only equipment which will increase the reliability of a service currently available at the NRMC should be considered. For example, a request for a new automatic blood cell counter might be justified primarily because it can complete more distinct tests with increased accuracy than the existing system. The

assumption was made earlier that the dependability of service was to be weighted equally with the utilization and life-saving factors. Therefore, any equipment which meets the criterion would receive a 25 per cent weighting factor.

The final criterion for weighting is the "better diagnosis and evaluation" factor. Equipment which would meet this criterion would be that equipment which would assist physicians and other medical personnel in interpretation and evaluation of patient needs. Any equipment which would result in an improvement in service of this factor would qualify under this criterion. For example, the proposed fourth-generation computed tomographic scanner purchase for NRMC San Diego presents a clearer, more precise picture than the present second-generation scanner. This improvement in resolution enables physicians to detect smaller irregularities in patient tissues and bones, and to more accurately locate and size tumors in pre-operative evaluation. This criterion differs from the greater dependability of service criterion in that that criterion is an increase in the reliability of service to the patient. That increased reliability is an input into the physician's diagnosis and evaluation of a patient. The better diagnosis and evaluation criterion, as illustrated by the computed tomographic scanner example, actually presents the physician with the diagnosis and evaluation. This he or she uses in determining a correct course of action. Again, because all

four criteria are assumed to be equally weighted, the author feels that equipment meeting th criterion would receive a 25 per cent weighting factor.

D. COMPUTATION OF THE OUTPUT RATING FOR EQUIPMENT

For purposes of illustration, the computed tomographic scanner requested by the radiology department at NRMC San Diego will be used as an example throughout this section.

Because the long-range objectives of NRMC San Diego did not specify a desired utilization rate, the author initially assigned 25 per cent as that figure, based on the literature used as references in this study. For interviews with hospital administrators at NRMC San Diego there was no disagreement with this figure, so it was retained as the desired utilization rate for proposed investment equipment items. In determining the relative weighting of the three qualitative factors, it was decided to weight these factors based upon the results of the survey (Figure IV-1). Using the 358 points totalled by the expected utilization criterion as a base, the other three criteria selected were expressed as a percentage of that base in Figure IV-2. These percentages were then multiplied by the desired utilization rate of 25 per cent to obtain weightings relative to that figure. These figures were then rounded as indicated for ease of calculation. These final weightings were then applied to the four factors in the output formula. It was decided

that equipment which could save five or more lives, for any type of patient, should receive the full weighting for that criterion. Any less than five lives saved would receive a proportionate amount of that weighting.

	Total Survey Points	Percentage of Base	Desired Utilization Rate	Actual Weighting	Weighting to be used
Utilization Rate (1)	358	100.0%	.25	25.0%	25%
Potential Life-Savings (2)	432.5	120.8%	.25	302.0%	30%
Greater dependability (8)	355	99.2%	.25	24.8%	25%
Better diagnosis & evaluation (10)	419	117.0%	.25	29.3%	30%

Figure IV-2. Determination of relative weightings for output analysis

In Figure IV-3, the output rating for the computed tomographic scanner is determined. The estimated percentage utilization is arrived at by determining the number of services that could theoretically be rendered in a 24-hour period. An estimate is then made of the expected number of services that will be rendered each day. These estimates were obtained from equipment maintenance records and the OPN Equipment Budget Item Justification Worksheet. The expected number of services to be rendered is then divided by the theoretical number of services that could be rendered each day. (If a 100 per cent utilization is not expected to be

(Col 1) Type of Equipment	(Col 2) Estimated Percentage Utilization	(Col 3) How Many Lives are Expected to be Saved by the Equipment?		(Col 4) Will Equipment Provide Greater Dependability of Service?		(Col 5) Will Equipment Permit a Better Diagnosis and Evaluation?	
		Number of Lives	Total Weighting Assigned	Yes or No	If Yes, Weighting Assigned	Yes or No	If Yes, Weighting Assigned
1. Computed Tomographic Scanner	13%	25	30%	No	---	Yes	30%

(Col 1) Type of Equipment	(Col 6) Total Weighting Assigned to All Four Factors	(Col 7) Estimated Economic Life	(Col 8) Total Hours Available Over Estimated Life	(Col 9) Combined Output Rating (Col. 6 times Col. 8)
1. Computed Tomographic Scanner	73%	5 years	43,800	31,924

Figure IV-3. Determination of output rating for computed tomographic scanner at NRMC San Diego.

constant over the life of the equipment, then the percentage of utilization would have to be estimated for each time period that the rate of utilization is expected to change.) For this type of estimate, where expected utilization will not be constant over the life of the equipment, the percentage of utilization should be an average over the life of the equipment.

The next column in Figure IV-3 provides for a consideration of the life-saving potential of the equipment. First, the number of lives the proposed equipment will save must be estimated. This estimate was obtained from the chief of service of the department submitting the request. You will recall from the earlier discussion of life-saving potential that this analysis assumes that five or more lives saved (over the life of the equipment) would receive a weighting of 30 per cent. Any less than five lives saved would receive a proportionate amount of the 30 per cent weighting factor.

Column (4) in Figure IV-3 allows for evaluation of the increase of dependability criterion. If the greater dependability of service is a prime consideration in the request for an item of equipment, the first column should be answered yes. If this factor is not a prime consideration in the equipment request, the first column should be answered no. A no answer would indicate that no wieghting should be assigned to this factor. A yes answer for this factor would

mean that a weighting of 25 per cent should be assigned to it.

Weighting for column (5), the better diagnosis and evaluation factor, is determined in much the same manner as column (4). If this terion is a primary consideration in the equipment request then a yes answer and a weighting of 30 per cent would be assigned. If this criterion is not a primary consideration, then a no answer and a weighting of zero would be assigned.

The weightings assigned to each of the four factors are totaled in column (6). The estimated economic life is then determined from the OPN Equipment Budget Item Justification Worksheet and Enclosure (1) to Appendix A. The total hours available per year is 8,760 (24 hours per day 365 days per year). The total hours available over the estimated economic life of the equipment is then entered in column (8).

Column (9) provides for the total combined output rating. This is computed by multiplying the total weighting assigned to the four factors [column (6)] by the total hours available over the estimated economic life of the equipment [column (8)].

One final point should be made about the weightings allocated to the factors in this chapter. The management of a NRMC or hospital could select any relative ranking of the four factors considered for inclusion in this output analysis or any of the other factors discounted earlier. It is

intended that once a method of weighting has been established by management, the weightings should not be changed. The constant weighting of these factors would permit a consistent use of the method of analysis. An exception to the use of constant weightings would be a situation where the long-range objectives of the facility have been changed. This situation would justify a reconsideration of the weightings that are assigned to these factors.

V. INDEX OF SERVICE FOR RANKING EQUIPMENT PROPOSALS

A. INTRODUCTION

In this chapter the results of the input analysis of equipment and output analysis of equipment discussed in Chapters III and IV, respectively, are combined to compute the index of service. The purpose of this chapter is to discuss the computation of the index of service, to evaluate the index of service and to discuss special problems associated with the use of this analysis and other aspects of the method of analysis.

B. DETERMINATION OF THE INDEX OF SERVICE

The index of service is computed by dividing the net cost (inputs) into the service rating (outputs). The result of the computation is the output rating per dollar of net cost which is referred to in this study as the index of service.

Again referring to the computed tomographic scanner as an illustrative example, the index of service can be determined. The output rating of 31,974, which includes a relative weighting of the utilization, life-saving potential, greater dependability, and better diagnosis and evaluation factors, was determined in Chapter IV. The input or net cost computation of $1,776,696 was calculated in Chapter III and includes a consideration of incremental acquisition cost,

incremental operating cost, and total net outlay cost. By dividing the net cost into the output rating, and index of service of 0.018 is obtained. The use of this index for the ranking of requests provides the decision-maker with a tentative ranking of all items.

C. EVALUATION OF THE INDEX OF SERVICE

The author feels that the index of service can be of real assistance to the decision-maker. However, it is extremely important that the index and tentative ranking of equipment requests be used with a complete understanding of the underlying assumptions and limitations.

The new cost from the input analysis and the output rating from the output analysis are the two items that are used to compute the index of service. The user of the index should be thoroughly familiar with the assumptions and procedures used to compute the output rating.

One assumption was that the use of time to measure the utilization of equipment is a good indication of the quality of service that is provided. The use of this time criterion was justified primarily because it is a common denominator which can be used for comparing requests for new equipment within and among departments. This means that the quantity of service for an instrument sterilizer and an x-ray machine would both be measured by the item each item of equipment was utilized. The use of this criterion for measuring the

quantity of service does not provide for the fact that the utilization of the x-ray equipment for one hour might be more important than the use of an instrument sterilizer for one hour, or vice versa. It is important, therefore, that the user of the index of service be aware of this assumption underlying the measurement of the quantity of service.

In addition to a measure of the quantity of service by expected utilization, the output analysis includes a weighting of three factors which pertain to the quality of service. The three items weighted are life-saving potential, greater dependability of service, and better diagnosis and evaluation. These qualitative items were weighted in relation to a desired level of utilization for similar types of equipment. The example in this chapter dealing with the computation of the output rating assumed that a desired utilization level was 25 per cent. This was the basis for assigning weights to the three qualitative factors which were weighted proportionally with utilization based on survey results.

If, for example, all the proposals for a certain fiscal year had a utilization of about five per cent, this would mean that the three qualitative factors would receive a more favored weighting that was originally intended in the output rating. Therefore, the basis for assigning weightings should be understood and considered by the user when soliciting among the various equipment requests.

In considering qualitaive items for inclusion in the output analysis, several factors were not included. These factors in total represented approximately 44 per cent of the total response to the survey of considerations in investment equipment purchases. These items should also be considered by the decision-maker in conjunction with the tentative ranking that is provided by the index of services.

The method of analysis used in this study is applicable only to medical equipment proposals. Such items as galley equipment and floor polishers must also be purchased from other procurement Navy funds. To apply the index of service approach to these items would result in a very low index of service, as they would receive no weighting in the three qualitative factors. These items are essential and must be purchased at some stage.

Several limitaions in the use of the index of service have been discussed in the preceding paragraphs. It is the opinion of the author that the index can provide a very useful service to hospital managers regardless of these limitations. The index of service provides a tentative ranking of equipment requests. The tentative ranking can give the decision-maker objective evidence to be used in turning down an equipment request. Without this evidence, the only alternative may be to approve the requests of the most vociferous chiefs of service.

The form for the method of analysis provides a logical guide for the accumulation of information that is relevant to the equipment decision. The form will, therefore, serve as a checklist in the completion of the equipment analysis. The index of service is intended to provide a preliminary basis for the selection of equipment requests. The ranking provided by the index should then be tempered by the judgement of the decision-maker.

D. SPECIAL PROBLEMS ASSOCIATED WITH THE INDEX OF SERVICE

One factor not included in the method of analysis is the risk associated with types of projects. It might well be that the probability of achieving the estimated inputs and outputs for an item of equipment in the labor and delivery department is higher than for proposed projects for the surgery department. This factor is not provided for in the analysis; however, the decision-maker should consider the various probabilities in the decision-making process.

The index of service, because of its input basis of net cost, is biased toward lower cost equipment. This is necessarily so because the objective of this study was assumed to be the provision of equipment which would maximize service to patients with a limited amount of funds in the long run. Departments such as radiology will, in most cases, be made to look bad, relatively speaking, because of the higher costs of their equipment in relation to other

departments. Again, the decision-maker must be aware of this fact in the equipment proposal process.

E. SUMMARY

Using the input analysis and output analysis derived in earlier chapters, a ratio defined as the index of service was determined in this chapter. This index of service was then applied to one example in illustration. This precise calculation is not without assumptions or limitations, however. The output measure is based on relative weightings of factors to an assumed desired utilization. Also, several factors given consideration by the NRMC San Diego chiefs of service were not included in the output analysis because they did not individually constitute a significant portion of the survey results. Other problems associated with the index of service is the exclusion of risk analysis in the measurement of inputs and outputs, and a bias toward lower costing investments. Despite these apparent problems, the author feels that the index of service is an excellent method for tentative ranking of equipment proposals prior to evaluation by the decision-maker.

VI. RESULTS OF THE FIELD TEST OF THE METHOD OF ANALYSIS

A. INTRODUCTION

There were three objectives in testing the method of analysis which is proposed in the author's study. These objectives were:

1. To determine whether it is feasible to collect the data required in the method of analysis;

2. To determine whether it is necessary to make revisions to the method of analysis;

3. To provide an example of how the equipment evaluation may be applied.

B. EQUIPMENT ITEMS SELECTED FOR EVALUATION

Five items of equipment were selected for the field test. These five items were the top five requests by the Naval Regional Medical Center (NRMC) San Diego in their FY 82 investment equipment requirement letter. NRMC San Diego was chosen as the test site because it was found by the author in conversations with Bureau of Medicine and Surgery (BUMED) officials to have an exemplary reputation in maintenance and thoroughness of financial records in the capital budgeting area [Ref. 28]. The professional service departments represented in the study were radiology, outpatient laboratory, internal medicine (two), and cardiology. The

items requested by these departments will be briefly described in order beginning with the top priority.

A computed tomographic scanner, commonly referred to as a cat scan, which was requested by the radiology department was examined. This equipment is used to present x-ray scans of the head and body of patients. the purchase of this equipment is considered essential because this machine can provide high resolution of subcranial abnormalities which the present unit is incapable of accomplishing. The processing time of the proposed unit is far superior to the present unit and is expected to alleviate the current backlog of both head and body scans. Finally, the age and material condition of the present unit have made it unreliable and it is incurring increasing repair costs.

The number two priority item requested by the outpatient laboratory was for an automated blood cell counter. This unit of equipment is intended to replace an 11 year old unit which has become uneconomical to operate. In addition to performing more types of blood tests at greater speeds and more accurately than the older unit, the proposed unit is much more compact and will occupy less bench space.

The third item, requested by the internal medicine department, was a gas system sterilizer. The purpose of this system is to sterilize therapy equipment. This system is considered a break-through in the field and will replace the present cold chemical decontamination system. The current

system does not meet accreditation standards. The command's Infection Study Team feels that the proposed system would drastically reduce non-social infection cases.

The fourth requested item, also from the internal medicine department, was a portable defribilator and cardioscope. This equipment is used to defibrilate and monitor cardiac patients in emergency rooms and in transit. This equipment is a replacement item for an eight year old piece of equipment considered obsolete and unreliable. The addition of this proposed equipment will improve patient monitoring during and following cardiac arrest.

The last piece of equipment examined in this survey was an electrocardiograph (ECG) cart. This piece of equipment is intended to be used in conjunction with the Computer Assisted Practice of Cardiology (CAPOC) System currently operational at the NRMC. Addition of the ECG cart will improve turnaround time of ECG analysis at branch clinics through interaction with the CAPOC system.

C. RESULTS OF THE FIELD TEST

The results of the field test are summarized in Appendix E. Costs supporting these computations are listed in Appendix D. All data was obtained from manufacturer's proposals, OPN Equipment Budget Item Justification Worksheets, equipment maintenance records and interviews with the applicable chiefs of service. Highlights of the cost

data accumulated for the input analysis will be discussed below.

In all five examples the transportation cost was included in the invoice price. Installation costs are a required entry on the Other Procurement Navy (OPN) Equipment Budget Item Justification Worksheet and are calculated by a public works survey.

Training costs for the computed tomographic scanner include all supplies and expenses used while personnel are in training. Training is provided by the manufacturer at his site. Training cost for the automated blood cell counter consists solely of transportation cost to and from a United States Navy sponsored school.

Only the computed tomographic scanner required additional working capital. For the purposes of the author's analysis working capital will be defined as current assets [Ref. 29]. The additional working capital in this case is the increase in inventory necessitated by a second CAT scan. To calculate the salvage value of costs released because of this equipment the author used the current book value (cost minus accumulated depreciation) of equipment being replaced.

Depreciation costs were determined assuming a straight-line rate through out the lifetime of the equipment. The estimated lifetime was that suggested by BUMED in Appendix A. Salvage value, then, was the present value of the book value of the equipment and working capital at some future time. The

future time used in this calculation was the applicable chief of service's estimate of the replacement date when factors such as technology improvements are considered.

The incremental operating cost per annum was computed using data from the OPN Equipment Budget Item Justification Worksheet. Only the power cost had to be calculated by the author. For this figure manufacturer's estimates of power usage and current commercial power usage rates obtained from San Diego Gas and Electric Co. (SDG&E) were applied. For ease in comparison the incremental operating costs were estimated to be uniform throughout the life of all the equipment items examined. Other utilitites, floor space, and insurance were cost elements not found to play a part in the five items of equipment analyzed.

The next item to be completed was the output analysis. Prior to conducting the analysis the author discussed the survey results and relative weightings assigned in Chapter IV with senior NRMC administrators. These officials for the most part found no fault with the methodology and results but desired to reserve their comments until the field test was completed.

In determining the estimated utilization rate the author looked at maintenance records for similar data to determine the anticipated need for the equipment. Approximate processing time for each use was calculated from manufacturer's specifications and/or estimates by medical

personnel at NRMC familiar with the equipment and its applications. For equipment like the gas system sterilizer which is always in use the weighting for this utilization factor is easily determined. For equipment such as the automated blood cell counter, where operator expertise decides the majority of the time, this became more difficult and subjective. In this particular case the author used an average of several eatimates obtained from qualified biomedical technicians.

To correctly weight the three qualitative output measures (life-saving potential, greater dependability of service, and better diagnosis and evaluation) the author depended entirely on the opinion of the department chief of service responsible for the submission of the equipment request. The criteria were carefully explained to these chiefs of service with emphasis placed on the distinction between direct and indirect benefits. It is the author's opinion that the results accurately reflect the intentions discussed in this analysis. Finally, the total time available over the lifetime of the equipment was determined by calculating the total hours available in the BUMED estimated equipment economic life in Appendix A.

The index of service is then simply computed by dividing the net outlay cost derived from the input analysis into the output rating. The five items of equipment were ranked in order of the index of service and compared with their

ranking as determined by the Investment Equipment Review Committee (Figure VI-1). It was in this manner that they were presented to the NRMC administrators.

Ranking by Index of Service	Ranking by Investment Equipment Review Committee
1. Portable defibrilator and cardioscope	Computed tomographic scanner
2. ECG cart	Automated blood cell counter
3. Gas system sterilizer	Gas system sterilizer
4. Automated blood cell counter	Portable defibrilator and cardioscope
5. Computed tomographic scanner	ECG cart

Figure VI-1. Comparative ranking of investment equipment items by index of service and NRMC San Diego Investment Equipment Review Committee

D. COMMENTS RESULTING FROM THE FIELD TEST

The results derived in Figure VI-1 above were presented to Captain C.C. Atkins, Medical Corps, USN, Director of Clinical Services, NRMC San Diego, and Captain S.M. Richardson, Medical Service Corps, USN, Director of Administrative Services, NRMC San Diego with a request for their comments and evaluations of the field test.

Both of these administrators felt that there was a bias in the index of service against high cost items. This is a worthwhile point to consider. Theoretically, there is no upper limit on the net outlay cost for a piece of equipment. To remain competitive, were the index of service used as a ranking criteria, a high cost item such as the computed tomographic scanner would require a commensurate increase in

output rating. This is not possible because of the upper bounds imposed on the output measures. These limits were intended to reflect the objectives of the Investment Equipment Review Committee as evidenced by the survey results. If these administrators actually reflect the long-range objectives of the hospital more accurately than the survey results then the relative weightings of the factors or even the factors themselves can be revised. It was felt by the administrators that the life-saving potential of the computed tomographic scanner was not accurately reflected in the final results.

Another comment resulting from the field test was the apparent disregard by the author for improvements in technology which reduce utilization time but increase efficiency and/or effectiveness. For example, the automated blood cell counter can provide more tests more accurately and in less time than the present system. All other output factors remaining constant this equipment would have a lower utilization rate, and therefore, a lower output rating than the less capable system now in use. This inequity could be repaired if the "more timely completion of service" factor included on the survey had received more support. Again, the solution is the revision of factors and factor weighting if that is determined to more accurately reflect the long-range objectives of the NRMC.

One final point was brought out during the field test conducted by the author. The services that are provided by many types of equipment that would be subjected to this analysis are of an experimental nature at the time the equipment purchase is first proposed. Physicians are usually reluctant to use this item after it is first acquired. However, as more and more medical personnel become acquainted with the new equipment, their optimism or pessimism generally spreads very quickly to other members of the staff. For this reason alone, projections of equipment usage will in many cases not be constant over the economic life of the equipment. Constant usage was assumed in this analysis, however, at the rate of expected utilization for the first year. This treatment of utilization was given to estimates because it was conservative.

The general reaction of the personnel interviewed in connection with the field study was that the method of analysis provides a useful service to the decision-maker. The index of service provides a useful tentative ranking, and the information provided for in the method of analysis would be useful even if the index were not used for ranking purposes. It would be important for the user in this context to be aware of the assumptions and limitations discussed earlier. Another viewpoint expressed was that the equipment evaluation would enable the decision-maker to be objective with the chief of service requesting the new equipment. This

factor would assist in minimizing the affects of dominant personalities on the medical staff.

E. SUMMARY

The purpose of this chapter was to determine the feasibility of collecting the data necessary for computation of the index of service and test its applicability to the long-range objectives of NRMC San Diego. Five pieces of equipment were selected for testing the method of analysis. It was found that the data is indeed collectable and a meaningful index of service can be calculated.

In calculating the index of service for these five pieces of equipment, which represented the top five requests of NRMC San Diego for FY 82 several assumptions had to be made. The most important of these were that:

1. equipment being considered for purchase would have characteristics comparable to similar presently utilized equipment, except where noted
2. annual operating costs would remain constant over the estimated equipment economic life; and
3. utilization rate of the equipment would remain constant over the estimated equipment economic life.

The findings of the field test were collated and presented to two senior NRMC administrators for than comments. In summary their comments questioned the application of the long-range objectives ofthe NRMC as determined by the author's survey of the NRMC chiefs of service and the apparent bias against equipment items with high net outlay costs. However, both of these senior

administrators and many other medical personnel interviewed during the course of this field test felt that this method of analysis could be extremely helpful in a tentative ranking of equipment requests, by providing the decision-maker with an objective basis for that ranking.

VII. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

More formalized and analytical techniques are needed for analyzing capital expenditures for non-profit enterprises in general and hospitals and medical centers in particular. The results of a literature search by the author indicated that very little had been done in developing analysis techniques for hospitals and medical centers. What has been done is of such recency that evaluation of these techniques is impossible at this stage. The purpose of this study was to develop a method of analyzing proposed capital expenditures for purchase from Other Procurement Navy (OPN) funds at a Naval Regional Center (NRMC).

An assumption of this study is that the objective of a NRMC is to maximize its service to patients in the long run with a given amount of funds. Another assumption was that revenue dollars could not be used as a measure of service provided by a hospital. Hours of use, was therefore, used to measure the utilization (quantity of service) of equipment. The research methodology for this study consisted of a literature search and preliminary interviews with medical personnel at the Bureau of Medicine and Surgery (BUMED) and NRMC San Diego. The results of this pilot study and ideas of the author were used to generate an equipment evaluation

survey intended to enumerate objectives of the Investment Equipment Review Committee at NRMC San Diego. This committee which consists of senior administrators and chiefs of service determines the ranking of all equipment proposals submitted at NRMC San Diego prior to their transmittal to BUMED for funding. The returns from this survey were collated and the objectives receiving the most support identified. These objectives were then quantified as measures of the NRMC's service to its patients. Finally, the completed method of analysis was used to evaluate five items of equipment proposed for purchase at NRMC San Diego. The five items selected were the top five priority items submitted to BUMED for fiscal year 1982. The purpose of this field test was to determine whether it is practical to collect the required data, to determine whether revisions should be made in the method, and to provide an example of the application of the proposed equipment evaluation in the summary.

The method of analysis consists of three parts. These are the input analysis, output analysis, and index of service.

The input analysis which was discussed in Chapter III is intended to provide the necessary information for computing the net investment required over the estimated economic life of the equipment if the equipment were purchased. This portion of the analysis includes the determination of acquisition cost, annual operating cost and net outlay cost.

The first consideration of the author was to determine whether to use full cost or incremental cost data in the input analysis. It was decided to use only incremental cost data in the method of analysis as this provided more relevant information than full cost data. It was decided that all cash outflows would be adjusted to the time of purchase by the net present value technique to reflect the time value of money.

Finally, in the input analysis, the incremental acquisition cost is added to the time-adjusted incremental operating cost per annum to determine the total outlay cost. For purposes of this study it was assumed that all cash outflows occur simultaneously within a year and at the beginning of each year.

There are two aspects of the output analysis discussed in Chapter V. They are the quantity and quality of service. The quantity of output refers to the volume of service rendered or the equipment utilization, and the quality of output pertains to the nature of the service that will be provided by the equipment.

The first problem encountered was to select a unit to measure the utilization of equipment. Hours of use was selected as the unit of measure for utilization. This criterion was selected primarily because it would provide comparability for the interranking of requests from all

departments. The hours of use criterion assumes that time is a good indication of the quantity of service.

Considerable emphasis was placed on the qualitative aspects of output in this analysis. Nine factors were considered germane by the author for inclusion in the equipment evaluation summary. However, only three of these factors were seen by the author as receiving enough support to be given primary consideration in the new equipment decision. These three factors were: will this equipment save patient lives that otherwise would not have been saved; will this equipment provide a greater dependability of service to the patient, and; will this equipment provide a better diagnosis of patient needs.

In order to assign weightings to the qualitative factors it is necessary to consider the long-range objectives of the NRMC. It was decided by the author that the weightings of these four factors would be in the same relative proportion as shown by their survey results. By first determining a desired utilization rate (percentage) for proposed equipment the three qualitative factors could be proportionately weighted. In this analysis it was determined that a utilization rate of 25 per cent was desirable and the weighting of the remaining factors was assigned proportionately using 25 per cent as the base.

The total weighting determined above by summing the weightings of each individual factor should then be

multiplied by the total hours available over the ecomonmic life of the equipment to determine the output rating. For purposes of this study it was assumed that all equipment was available for use 24 hours a day. An example was presented in Chapter IV to illustrate the computation of the output rating.

In Chapter V the determination of the index of service was discussed. The index of service is simply computed by dividing the service rating (output) by the net outlay cost (inout). the result of this computation is the output rating per dollar of net cost. This index can provide the decision-maker with a tentative ranking of requests for new equipment from medical service departments.

The results of the field test of the method of analysis were discussed in Chapter VI. The three objectives in testing the method of analysis were to detemine whether it is feasible to collect the data required in the method of analysis, to determine whether it is necessary to make revisions in the method of analysis and to provide an example in this study of how the proposed equipment evaluation method may be applied. Five pieces of equipment were evaluated and the results explained to the two most senior administrators at NRMC San Diego. Their comments and observations indicated that they questioned the weightings and even the factors themselves that were included in the output measure. This could be attributed to the lack of

knowledge of NRMC long-range objectives or possibly misinterpretation of survey questions. In either event this situation, if it does require revision, can be easily adapted through variation of output factors and weighting. It was also found by the author during the course of the field study that for many types of equipment usage will increase over the economic life. However, constant usage was assumed in this analysis because it led to more conservative estimates.

The general reaction of the personnel interviewed in connection with the field test was that the method of analysis provides a useful service to the decision-maker. It was stated that the index of service would provide a useful tentative ranking, and that the information provided for in the the method of analysis would be useful even if the index were not used for ranking purposes. It would be important for the user of the index to be aware of the assumptions and limitations. Finally, the equipment evaluation would enable the decision-maker of the NRMC to be objective with the chief of service who is requesting the new equipment. This factor could help minimize the effect of dominant personalities on the Investment Equipment Review Committee.

B. CONCLUSIONS AND RECOMMENDATIONS

The results of this study indicate that there is a recognized need by personnel in hospital administration for techniques, such as those presented in this thesis, for

analyzing capital expenditures. Through the field test it was determined that the method of analysis proposed in this study can be used at a NRMC. It was also found that the data required for evaluation can be collected and that anticipated service from the equipment can be quantified.

There are two distinct advantages associated with the method of analysis suggested in this thesis. First, the recommended evaluation form will provide the decision-maker with a logical guide for the accumulation of revelant information. And second, the index of service will give a tentative ranking for all requests for equipment of this type.

It is extremely important that the user of this index have a thorough understanding of the underlying assumptions and limitations of the index of service. One assumption is that time is an accurate measurement of the quantity of service provided by equipment. With increased efficiency and reduced processing time of modern day equipment this assumption may soon no longer be valid. This assumption also affects the three qualitative measures of output which are correlated to the desired level of utilization. In addition to these assumptions underlying the computation of the output rating, there are factors which are not quantified and reflected in the index. These factors which were discussed in Chapter IV must be considered by the decision-maker in conjunction with the tentative ranking provided by the index

of service. Consideration of the assumptions underlying the computation of the output rating is necessary in order for the user of the index to avoid placing unwarranted emphasis on the results. This analysis is not intended to replace the judgement of the decision-maker.

A limitation of this study is the bias of the index toward low investment equipment. This can be attributed to the fact that the weighting of the output factors is limited by upper bounds while the new outlay cost used to calculate input has no such upper bound. Again, if the NRMC administrators determine it is necessary and in consonance with the long-range objectives of the institution weightings of the output factors can be revised. A second limitation of this study is caused by the inclusion of non-medical equipment in the OPN budget of the NRMC. This equipment, such as floor polishers and food service equipment, although necessary, would perpetually rank low using the index of service method of analysis. A solution to this limitation would be the annual allocation of a fixed percentage of OPN funds for the purchase of essential non-medical equipment. This determination, however, would have to be made at the BUMED level.

The author is of the opinion that the method of analysis suggested in this study will permit the user to make better-informed decisions. This is true even if the decisions resulting from the use of the recommended equipment

evaluation forms are no different than the decision that would have been made without the use of the method of analysis that is suggested in this study.

The results of this study indicate that a need exists for further research into the following areas.

1. Common measurment of services: The need exists for a recommended method of equating all services rendered by medical service departments. The problem is two fold:

a. all services rendered within a department need to be measured in terms of a common denominator; and

b. services rendered among the various departments should also be stated in terms of a common denominator. Various attempts have been made in this area, however, the results have not gained much acceptance and are considered unsatisfactory. A good common denominator, if it were developed, would be useful not only for the computation of the index of service, but for the performance measurement and appraisal of the various departments.

2. Utilization of equipment: A study regarding the utilization experience of various NRMCs and branch hospitals for these types of equipment would be helpful to a hospital administrator in making conclusions regarding the desired level of utilization for these types of equipment. This information would permit a more scientific determination of weightings that are used in the computation of the output rating.

3. Determination of objectives: The long-range objective of the NRMC were viewed differently by each chief of service responding to the survey. The composite results then differed from the long-range objectives as viewed by the top administrators. Establishing and quantifying long-range objectives would eliminate the need for surveying the field and more accurately reflect objectives in the output rating.

4. Probability associated with the estimates: Consideration should be given to the probabilities associated with various types of estimates. For example, estimates of patient need for one department may be more uncertain than estimates associated with another department. PERT and regression analysis are techniques that could be applied to forecast estimates of this type.

APPENDIX A

BUMEDINST 4235.5G
BUMED-43
13 March 1979

BUMED INSTRUCTION 4235.5G

From: Chief, Bureau of Medicine and Surgery

Subj: Programming of investment equipment requirements

Ref: (a) NAVCOMPT Manual, par. 074060
(b) Federal Register, vol. 41, No. 8, part IV, 13 Jan 1977
(c) Federal Register, vol. 42, No. 6, 10 Jan 1977

Encl: (1) Life Expectancy of Medical Equipment Guide
(2) Additional Justification of Triservice Equipment Approval
(3) OPN Equipment Budget Item Justification Worksheet
(4) Life Cycle Cost Analysis Worksheet
(5) Microfilm Equipment Justification Worksheet
(6) Navy Word Processing Program - Systems and Equipment Request, Parts Ip II, and III
(7) Customer Ordering List (COL) for Diagnostic W-ray Systems
(8) Manual Report of Lease/Rental Agreements
(9) Investment Equipment Budget Preparation
(10) Investment Equipment Inventory Report
(11) Format for Ssbmission of Monthly OPN Status Listing
(12) Bibliography of Instructions Cited

1. Purpose. To promulgate revised instructions and new procedures on programming of BUMED funded investment equipment requirements.

2. Cancellation. BUMEDINST 4235.5F is canceled.

3. Scope. This instruction is applicable to all BUMED managed commands and shall be used for programming investment equipment requirements. Reference (a) defines items of investment equipment and basically it is any item of equipment over $3,000 with the exception of vehicles. All mess and galley equipment over $3,000 are to be considered investment equipment and will be funded, beginning FY81, with Other Procurement, Navy (OPN) funds.

4. Background. The extreme competition for limited investment equipment resources has necessitated increased emphasis on the investment equipment program within the Navy Medical Department. BUMED must be able to perform detailed analysis on the investment equipment as well as have sufficient data

to justify various budget requests and to generate short-fused, one time reports in a variety of formats. These are some of the reasons why detailed justifieations - and limited automation of the investment equipment program are required. It is anticipated that more automation of the investment equipment program, especially in the area of the justification forms, will be required.

5. Replacement Program. Each command shall develop and maintain a formal equipment replacement program. A minimum program shall include:

a. An equipment review committee which shall meet as a group with the commanding officer and participate fully to develop the command's investment equipment budgets or additional (emergency) requirements after the budget submission. The equipment review committee will establish a priority for each item of equipment. There shall be only one priority system for the entire region. X-ray and laboratory equipment will not have separate priority systems nor will hospitals or clinics regionalized under centers. The minimum composition of the Equipment Review Committee shall be:

(1) Naval Regional Medical Centers/Clinics/Hospitals. Commanding officer, chiefs of services, a representative from each branch clinic, one staff CEC officer or activity CEC officer, and one biomedical equipment technician.

(2) Other BUMED Managed Commands. Commanding officer, department heads (or equivalent), a representative from each branch clinic, one staff CEC officer or activity CEC officer, and one biomedical equipment technician or dental technician repairman (or equivalent).

b. A continuing documented review of the age and physical condition of each item of investment equipment will be conducted. This action will assist in determining if an item should or should not be replaced. Enclosure (1) is a guide to use in determining the normal life expectancy of many items of equipment. Enclosure (1) should only be used as a juide since the condition and usage of the item of equipment will aid in determining if an item should be replaced.

c. Establishment of a formal preventive maintenance program as detailed in BUMED Instruction 6700.36 series.

d. Maintenance of an auditable record of investment equipment requirements, both replacement and new acquisitions, for:

(1) Current year. The fiscal year currently in progress (i.e., the current year as of the date of this instruction is FY79)

(2) Budget year. The fiscal year following the current year (i.e., FY80).

(3) Budget Year Plus One. The fiscal year following the budget year (i.e., FY81).

(4) Bsdget Year P.us two. The fiscal year plus one year following the budget year (i.e., FY82).

6. Equipment Requiring Triservice Approval. Medical equipment with a unit or system cost of $100,000 or more (except replacement X-ray equipment $200,000 or more) must receive triservice review and DOD approval prior to procurement. Additionally, reference (b) requires all Federal agencies to notify the appropriate mreawide clearinghouse, Health Systems Agency (HSA), and State Health Planning and Development Agency (SHPDA) of proposed health care programs and projects which includes equipment acquisitions that cost more than $200,000. Therefore, it is required, prior to any capital expenditures greater than $200,000 that appropriate notifications and request for comments be made concurrently to the appropriate areawide clearinghouse, HSA, and SHPDA which are identified in reference (c).

a. Definitions. For the purpose of triservice review, unit or system cost is determined as follows:

(1) Unit cost is the acquisition cost of the item plus attachments/components/accessories/installation or alterations cost.

(2) System cost is the acquisition cost of multiple unit cost plus attachment/components/accessories/installation or alteration cost (e.g., central monitoring system).

b. In addition to other requirements in this instruction, submission of any budget request for equipment items requiring triservice approval must provide the information indentified in enclosure (2).

7. Equipment Requiring BUMED Approval. Reference (a) defines items of equipment as investment and expense items. Standard and nonstandard items of equipment which meet the investment criteria of reference (a), shall be submitted for BUMED approval prior to procurement by completing an original and one copy of enclosure (3). Local reproduction of enclosure

AD-A115 162 NAVAL POSTGRADUATE SCHOOL MONTEREY CA F/G 6/5
AN ANALYSIS FOR CAPITAL EXPENDITURE DECISIONS AT A NAVAL REGION--ETC(U)
DEC 81 M E DOYLE

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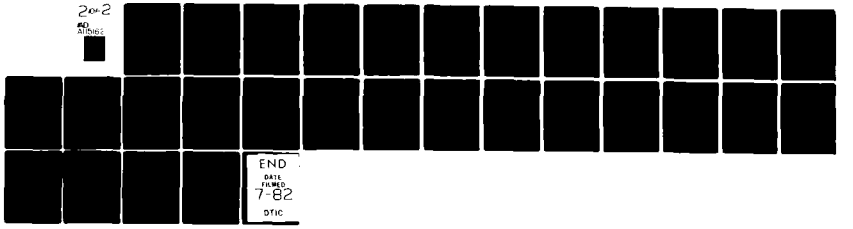
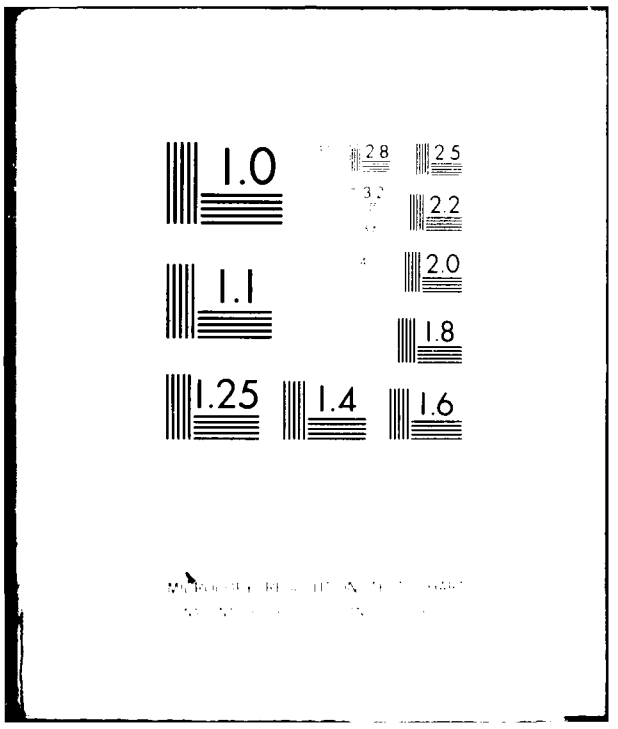
AD A115162

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(3) is authorized. For those items costing $15,000 or more, complete the Life Cycle Cost Analysis Worksheet in the format of enclosure (4) and submit with enclosure (3).

a. Requests for the following systems and equipment items require BUMED approval regardless of cost. Studies and surveys in support of systems and equipment requests shall be conducted independently by in-house or other Navy staff, or by impartial, third party study groups. Utilization of vendor survey teams is not recommended. Experience shows that, in most instances, the results, findings, and recommendations of such vendors' surveys must be considered biased. Usually, they are directed solely toward procurement of the particular manufacturer's product and therefore are not acceptable as valid substitutes for independent study and analysis. Submit studies, surveys, additional comment, and follow-on data directly to BUMED together with the vendor's proposal, cost quotation, and product brochures and specifications. Procurement action shall be initiated on receipt of technical approval by BUMED and shall not be effected on the basis of any prior authorization by higher authority.

(1) Hospital Communications Systems and Individual Equipment Items, including radio paging, two-way radio, telemetry, nurse call, audiovisual paging, intercom, etc. Submit all requests for radio communications and telemetry systems and for all individual equipment items whether for augmentation/add-on, updating, expansion, replacement or other action, to OPNAV via BUMED. As prescribed by OPNAVINST 2410.11F radio frequency allocation (DD Form 1494) for all systems and individual equipment items must be authorized prior to procurement. Submit requests for separately wired intercom systems to BUMED via the local NAVFAC engineering field division in accordance with procedures in the NAVFACINST 2305.7 series.

(2) Microfilm Equipment. Submit requests to OPNAV via BUMED with justification in accordance with enclosure (5).

(3) Reprographic (Quick Copying and Duplicating) Equipment. Submit all requests to BUMED. Each request must include the comments, authorization, and approval number of the local NPPS office obtained prior to submission in accordance with OPNAVINST 10461.8 series.

(4) Word Processing (Dictation and Automated Typing) Systems and Individual Equipment Items. Submit all requests for dictation systems and individual dictation/transcription equipment, and for automated (shared-logic and stand alone)

typing systems and equipment directly to BUMED. Prepare all requests in the format of enclosure (6). BUMED will obtain the necessary review and approval from higher authority in accordance with OPNAVINST 5210.12 series.

(5) Filing Equipment. In consonance with the moratorium on procurement of all filing equipment imposed by SECNAVINST 10463.1 series, a request for an exception is required. The request should include detailed information to enable OPNAV to review and authorize purchase. Data as to the number, age, and condition of present filing equipment should be given as well as the make and model(s) of new/ replacement filing equipment, the number required, purpose served, GSA contract number, and costs. To assure favorable consideration, present filing equipment should be utilized to the maximum extent practicable, and any excess equipment considered. If suitable excess equipment is not available, a statement should be made to this effect.

(6) Automatic Data Processing Equipment including Data Communications Equipment. Submit requests to BUMED in accordance with OPNAVINST 5236.1 series and Naval Medical Data Services Handbook, NAVMED P-5069, regardless of appropriation or method of acquisition.

(7) Diagnostic X-Ray Systems (Less Dental). The Defense Personnel Support Center (DPSC) is the procuring agency for all medical diagnostic X-ray systems. Enclosure (7), the DPSC Customer Order List (COL), contains instructions therein for use. A technical data package must be included with each OPN equipment budget item justification worksheet for each requested diagnostic X-ray system. Upon delivery of X-ray systems under the COI DPSC requires that the military services complete an acceptance inspection package for each unit. This inspection package is to insure that each system will perform to the specifications set forth by the contract and manufacturer's technical production data. The Inspection/Acceptance Report may be used as a basis for determining warranty defects for a quality report which will be submitted to DPSC-AX during the warranty period. The Army Depots at Tracy, CA and Tobyhanna, PA have personnel trained in the required inspection procedures and their services may be obtained upon request. An interservice support agreement is in effect, and the procedures for use are outlined in BUMEDINST 6700.36 series. O&MN funding will be required to effect the acceptance inspection. Questions relative to the preparatin and use of COL may be directed to DPSC-AX autovon 443-2896/3147.

(8) Lease or Rental of any Equipment, Material, or Service. Comply with the reporting requirements of enclosure (8).

If any of the above items are included in budget year submission the provisions of this paragraph should be complied with at the same time in order to obtain final approval prior to funding.

b. Installation expenses for investment equipment that are chargeable to the appropriation Other Procurement, Navy (OPN) must be included in the acquisition cost of the equipment. Guidance for these installation expenses are defined in NAVCOMPT 075201. Installation which requires structural modification/changes to utility systems, or other preparatory work that is accomplished by public works departments or through other contractual arrangement other than those identified in the original purchase document are properly charged to the command O&M,N Appropriation. If the installation is not performed by the equipment supplier then it is not a proper charge to the OPN Appropriation. Charges to O&M,N which exceed the funding authority of the local command shall be prepared and submitted in accordance with OPNAVINST 11010.20 series.

c. Various instructions and administrative regulations issued by other than BUMED will, at times, require submission of requisitions (DD Form 1149). If these items are to be procured with BUMED allocated funds, submit the DD-1149's to BUMED for processing.

8. Preparation of Requisitions. Requisitions (DD Form 1149) are required only in those cases when source documents or EAM cards are not submitted in accordance with this instruction. Requisition numbers shall be constructed as prescribed by NAVCOMPTINST 7300.99 series for all DD-1149's, EAM cards, and source documents.

9. Sources of Supply

a. Department of Defense Supply System. Comply with Naval Supply Publication 437 (MILSTRIP/MILSTRAP).

b. Federal Supply Schedule Contracts. Federal supply schedule contracts should be utilized insofar as possible for the procurement of equipment not available from the Defense Supply System.

c. Open Purchase. Nonstandard items not available through the federal Supply Schedule may be procured locally

subject to the provisions of NAVSUP Manual paragraph 22000 and 22002. The provisions of the Defense Acquisition Regulations (DAR)(ASPR) must be complied with in all procurement actions.

10. Funding

a. Investment equipment must be procured with funds from the OPN Appropriation. OPN administrative procedures will be announced with the allocation of funds.

b. Research, development, test and evaluation (RDT&E) equipment is not presently classified as investment equipment and is funded from the appropriation, RDT&E. Requests for RDT&E equipment should comply with BUMEDINST 3900.3 series. Do not include these items in the investment budget.

c. Investment equipment required by an activity within the Clinical Investigation Program (CIP) shall be subimtted in accordance with BUMEDINST 6000.4 series. Do not include these items in the investment equipment budget.

d. Collateral equipment requirement for the initial outfitting of construction projects shall be included as a part of the project submission. Do not include these items in the investment equipment budget. Comply with the prerequisite actions in paragraph 7 above for all systems and equipment items in the project that require prior technical approval by BUMED.

e. Vehicular equipment as defined in NAVCOMPT 036004 and civil engineering support equipment are budgeted for and funded by the Naval Facilities Engineering Command. Requirements should be submitted in accordance with BUMEDINST 11240.4 series. Do not include these items in the investment equipment budget.

f. Materials handling equipment as defined in NAVCOMPT 036004 is budgeted for and funded by the Ships Parts Control Center. Requirements should be submitted in accordance with SPCCINST 10490.1 series. Do not include these items in the investment equipment budget.

g. While there is no prohibition against using appropriated funds in support of nonappropriated activities, complications do arise. Special services equipment which is "income producing" through the collection of a use of rental fee should be financed with nonappropriated funds. Requirements of this nature should be submitted with the Operating Budget of Nonappropriated Funds in accordance with chapter 6

of BUPERSINST 1710.11 series. Do not include these items in the investment equipment budget.

11. Annual Submission of Investment Equipment Requirements

a. Submit by letter of transmittal to reach BUMED, not later than 15 June each year, an original and one copy of the following:

(1) Investment Equipment Budget for the Budget year (see enclosure (9)).

(2) OPN Equipment Budget Item Justification Worksheet for each item (see enclosure (3)). Submit original in priority sequence and the copy in service code sequence.

b. Submit by letter of transmittal to reach BUMED not later than 15 March each year, an original and one copy of the following:

(1) Investment Equipment Budget for the Budget Year Plus One, (see enclosure (9)).

(2) Investment Equipment Budget for the Budget Year Plus Two, (see enclosure (9)).

The letter of transmittal shall indicate the number of source documents or EAM cards submitted and the aggregate dollar value of each submission.

12. Cancellation of Prior Year Budget Items. All unfunded budget items for the current fiscal year should be considered canceled at the time of preparing the budget year submission. This will insure proper prioritization of total command requirements.

13. Maintenance of Priority Investment Equipment Budget Listings. Investment equipment budget listings must be maintained in the order of command priority. Revisions should occur only when prior year budget items are reinstated or when new requirements are generated or priorities change. Additions or deletions to priority listings which alter item priorities require source documents or EAM cards for all items affected. Submit revisions as they occur.

14. Interim Requirements. Requirements generated between the budget submissions may be submitted as the need arises, submitting the documentation established by enclosure (3) and in compliance with enclosure (9). A well planned equipment program will obviate the need for most addenda.

15. Investment Equipment Inventory Reporting

a. For budget purposes and in order to comply with numerous reporting requirements placed on BUMED, it is necessary that this Bureau maintain a master inventory of investment equipment items held by each command. It is most important that this inventory remain current so that OPN budgeting by the commands, and reports required of BUMED, can reflect the true requirements of the Medical Department. Additionally, total dollar value of investment equipment on hand and its condition is one of the factors used in determining the allocation of funds.

b. All items of equipment under BUMED management control having a unit book value of $1,000 or more must be reported to BUMED on a quarterly basis. (See enclosure (10)).

c. A monthly OPN Status Listing (MED 4550-3) by FY OPN appropriation must be submitted in the format of enclosure (11) to reach BUMED no later than the 10th day of the following month for the month being reported.

16. Trials and Tests. No item of equipment shall be accepted by the activity or by any staff member for trial or test without prior approval of BUMED. Requests shall be submitted in accordance with BUMEDINST 6700.33 series.

17. All references listed herein contain pertinent information and should be reviewed prior to preparation of the investment budget. Mandatory compliance with all instructions, procedures, and formats contained herein is required. All budget and equipment inventories will receive machine edit and be returned to the command for correction before use by BUMED.

18. Enclosure (12) is a listing by number and subject of all directives cited in this instruction.

19. Report/Form. The quarterly Master Investment Equipment Inventory Report required by paragraph 2 of enclosure (10) is assigned report symbol MED 4550-1. The annual report of Lease/Rental Agreements as required by paragraph 2 of enclosure (8) is assigned report symbol MED 4550-2. The monthly report of OPN Status Listing required by paragraph 15c and submitted in accordance with enclosure (11) is assigned report symbol MED 4550-3. NAVMED 6700/3, Medical/Dental Equipment Maintenance Record, is available from COG II, Navy Supply System under stock number S/N 0105-LF-226-7031.

BUMEDINST 4235.5G
13 March 1979

W. P. ARENTZEN

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FSC CLASS 4110

Item	Years	Item	Years
Refrigerator, Blood Bank	10	Refrigerator, Commercial	10

FSC GROUP 49

Polisher, Floor	8

FSC CLASS 6515

Analyzer, cystic fibrosis	8	Infusion pump	10
Analyzer, gas	10	Inhalator	5
Analyzer, oxygen	6	Inhaler unit, gas anesthesia apparatus	7
Anesthesia apparatus, gas	12	Light, diagnostic, examination	10
Apparatus, resuscitating	10	Light, slit, ophthalmological	12
Aspirator, uterine evacuator	8	Monitor, blood pressure	8
Audiometer	10	Monitor, cardiac patient	8
Blood warmer	10	Nebulizer	10
Booth, audiometric	12	Operating apparatus,ear,nose,and throat	12
Breathing unit, positive pressure	8	Ophthalmometer	12
Capsule machine	15	Pacemaker/heart rate monitor	8
Cardioscope	8	Phoropter	12
Cart emergency	8	Pipette, automatic	10
Cautery unit	10	Proctoscope	10
Conductivity tester	10	Projector,ophthalmological acuity test	10
Cryosurgical system	8	Pulmonary function equipment	10
Cutter, orthopedic cast	8	Pump, infusion	8
Cystoscope	10	Resuscitator	8
Defibrillator	8	Resuscitator and aspirator	8
Dermatome	8	Saw, bone cutting autopsy	8
Dialyzer apparatus	8	Slit lamp	10
Electrocardiograph	8	Spirometer	8
Electroencephalograph	10	Stereoscope, vision testing	8
Electromyograph	8	Suction and pressure apparatus,surgical	6
Electronystagmograph	8	Suction apparatus, surgical	6
Electrosurgical apparatus	10	Tent, oxygen	8
Electrosurgical set	10	Test set, audiometer calibration	8
Fiber optics system, diagnostic	12	Treadmill, electric	5
Heart-Lung system	8	Ulrtasonic cleaner	10
Hypodermic injection apparatus,jet automatic	8	Vectorcardiograph	8
Hypothermia machine, introgastric	8	Vision test apparatus, color threshold	10

FSC CLASS 6520

Item	Years
Casting machine	10
Chair, dental operating	10
Collector unit, dust	10
Compressor, reciprocating, power driven	8
Dental operating unit	10
Evacuator, oral cavity, dental	10
Furnace, dental laboratory, elect	8
Grinding and polishing machine, dental lab	8
Light, dental operating, ceiling	10
Light, dental operating unit	10
Mixer-investor, vacuum, dental	8
Processing unit, dental resins	12

FSC CLASS 6525

Item	Years
Camera, closed circuit television	10
Cassette changer	8
Collector, silver, automatic	10
Control unit, X-ray apparatus	8
Control unit and tube-transformer head X-ray apparatus	8
Cooler, X-ray film processing unit	8
Densitometer	12
Developing Tank, X-ray	15
Drier, photographic film	8
Drier, X-ray film	8
Image intensifier	8
Illuminator, X-ray film	12
Monitor, closed circuit television	10
Processing machine, photographic film	6
Processing machine, radiographic film	6
Processing machine, radiographic paper and developer assy	6
Processing mach.,radiographic film, auto	6
Processing unit, X-ray film	6
Rectifier assembly, radiographic and Fuloroscopic, X-ray apparatus	8
Silver recovery unit	10
Stereoscope, X-ray film, mounted	8
Table, field X-ray apparatus	8
Table, radiographic	8
Tank, master, X-ray film processing	6
Transformer, X-ray apparatus	8
Transformer and control, X-ray apparatus	8
Tsbe stand unit	8
Viewer, X-ray film	12
X-ray apparatus, dental	10
X-ray apparatus, radiographic	8
X-ray apparatus, radiographic and fluoro	8

FSC CLASS 6530

Item	Years	Items	Years
Bassinet and dressing table	8	Sterilizer, health and moisture l	
Bassinet, heated	8	medical instruments and suppli	12
Bath paraffin	15	Sterilizer, surgical dressing	12
Bath, whirlpool	8	Sterilizer, surgical instrument	12
Bed, hospital	12	Sterilizer, surgical instrument (portable)	8
Bed, electric	12	Sterilizer, surgical instrument and dress.	12
Cabinet, solution warming	12	Sterilizer, surgical instrument and	
Cart, hospital	12	dressing (portable)	8
Chair,examining and treatment,surgical,motor	12	Stretcher	15
Diathermy apparatus	12	Table, autopsy	12
Filter-mixer-tank unit,pharmaceutical process	6	Table, examining and treatment	12
Hydrotherapy	15	Table, obstetrical and gynecological	12
Incubator, infant	10	Table, operating	12
Light, infrared, physical therapy	10	Table, orthopedic	12
Light, surgical ceiling	10	Table, patient examining	12
Light, surgical field	8	Thermoregulator, patient	8
Light, ultraviolet, physical therapy	10	Ultrasonic apparatus, physical therapy	8
Light, surgical stand	10	Washer, bedpan and urinal	8
Moist heat apparatus, physical therapy	12	Washer, sterilizer, surgical instrument	12
Monitor, infant respirator	8		
Respirator, protable	10		
Respirator, mobile	10		

FSC CLASS 6540

Blocking unit, ophthalmic lens	12	Generator, ophthalmic lens	8
Cutting machine, ophthalmic laps	10	Heating treating unit, ophthalmic lens	8
Cutting machine, ophthalmic lens	10	Lens measuring instrument, ophthalmic	12
Deblocker, lens	10	Surfacer, ophthalmic lens	10
Edging machine, ophthalmic lens	10		

FSC GROUP 66

Item	Years	Item	Years
Analyzer systems, automatic	8	Incubator, bacteriological	10
Balance, analytical	12	Meter, hydrogen 10N test	10
Bath, water	15	Microscope	10
Biochemical analysis unit, micro	8	Microtome	10
Blood gas apparatus	6	Microfilm unit	10
Blood chemistry analyzer, auto	8	Oven, laboratory	10
Blood cell counter	10	Photometer, flame	10
Centrifuge, laboratory	12	Refrigerator, blood bank	10
Chromatograph, gas	8	Scanner, isotope	8
Colorimeter, comparative	10	Slide stainer, laboratory	10
Counter, microscopic particle	10	Spectrophotometer	10
Counting paapratus	10	Tissue processor, automatic laboratory	12
Demineralizer	8	Washing machine, glassware	8
Distilling apparatus, laboratory	8		

FSC GROUP 73

Cart, food/tray, heat/refrig	10	Fryer, deep fat	10
Cooker, prsssure food	10	Griddle	12
Counter, food service	15	Kettle, steam jacketed	15
Dishwasher	10	Oven baking	15
Duplicator	10	Oven roasting	15
Food chopper	15		

FSC GROUP 74

Dictating equipment	10	Photocopier	10
Microfilm unit	10		

FSC GROUP 79

Floor scrubbing machine	8	Polisher, floor	8
Floor waxing machine	8		

ADDITIONAL JUSTIFICATION OF TRISERVICE EQUIPMENT APPROVAL

1. Additional justifications for medical equipment requiring triservice approval. Provide:

a. Equipment description including model or manufacturer's number.

b. Complete functional description of intended use of the proposed equipment.

c. Description of how the function in item b above is presently being accomplished.

d. Specific workload to be accomplished. List the procedures by type and number.

e. Quantity and current use of similar items supporting the workload in item d above.

f. Details as to any savings in time, money or personnel expected. Detail any increase in workload expected.

g. Description of facility modifications required with cost estimates and/or other installation costs required.

h. Number of personnel qualified to use the item and staffing projections. Include costs of training operators, if required.

i. Statement concerning maintenance capability or availability. Requests for replacement of existing items shall include a copy of the historical maintenance record.

j. Evidence of availability of similar equipment in other DOD, Federal, or civilian health care facilities. As a minimum the evidence must include:

(1) Location of the other facility and its distance from the activity.

(2) Cost per procedure from the other facility.

(3) Any patient transportation, travel, or per diem costs.

(4) Reasons why the other facility cannot satisfy the requirement.

(5) If the service is not available from the facilities, a statement to that effect is required.

k. Written recommendations of the appropriate DOD Regional Review Committee.

l. A cost/benefit analysis in the following format:

COST/BENEFIT ANALYSIS

1. Description (include all attachments or accessories make, model, and manufacturer).

2. Workload (list types and numbers of procedures to be performed annually).

3. Procurement costs:

Unit cost	$
Transportation	
Installation	
Facility modification	
Training	
Total fixed cost	$_____

4. Life expectancy of the item or system.

5. Annual allocation of fixed cost (total fixed costs divided by life expectancy).

6. Annual operating costs (must be based on workload item 2 above).

Consumable supply cost	$
Maintenance costs	
Personnel costs *	
Total annual operating cost	$_____

* Include personnel costs only if additional personnel are required. If personnel costs will be reduced the costs savings should be subtracted from operating costs. Use standard tables to determine personnel costs.

7. Total annual costs (annual allocation of fixed cost plus total annual operating costs).

OPN EQUIPMENT BUDGET ITEM JUSTIFICATION WORKSHEET

_____ FY19____ _____
ACTIVITY SUBUNIT I.D.#

_____
SUBUNIT LOCATION

Service/Division _____ Date _____

Requistion No. _____ Priority _____

SECTION I. FUNCTIONAL DATA ON EQUIPMENT ITEM REQUESTED. (To be completed by the requestor.)

a. Requested item's name: (use generic term) _____

b. Manufacturer: (Your 1st choice) _____
Model: _____

c. Manufacturer: (Your 2st choice) _____
Model: _____

d. Accessories: (Your 1st choice) _____

e. Total acquisition cost, including accessories: $____

f. Describe requested item's function. _____

g. Item has characteristics and capabilities essentially the same as item being replaced. If yes complete section II yes____ no____

h. Item is an additional item to provide additional capacity yes____ no____

i. Item is replacing an item, and is required because of state-of-the-art advances. (If yes complete Section IV) yes____ no_____

j. Item is requested because of a mission, task, or function change. yes____ no_____

k. If h, i, or j were answered yes, state how this item will satisfy the requirements. _____

_____

_____

_____

l. Life expectancy. _____years

If item is part of a system, what is the life expectancy of the remainder of the system? _____years

m. Does acquisition cost include installation provided by manufacturer? yes____ no_____

If yes, how much of the acquition cost is the installation cost? $_____

n. What is the O&M,N installation cost to install equipment? (electrical, plumbing, structural, medical gases, air conditioning, etc.) $_____

o. Does the item have any unique electrical or plumbing requirement? yes____ no_____

If yes, have they been brought to the attention of the staff or a civic engineer? yes____ no_____

p. Annual cost to provide consumable supplies for equipment. $_____

q. Will mdditional personnel be required to operate this item, it this equipment is purchased? yes____ no_____

If yes, then complete the following display:

Number	Corps/Civilian	Speciality	Grade/Rate	Salary

r. Will this item of equipment require personnel to receive additional training? yes____ no_____

If yes, where will personnel receive the training and what is the cost? $_____

s. This item of equipment will be utilized in: (check one)

_____ outpatient service area
_____ inpatient service area
_____ both outpatient and inpatient service area
_____ neither outpatient nor inpatient service area

SECTION II. WORKLOAD DATA RELATIVE TO ITEM BEING REQUESTED

a. What will be the estimated workload of the item? (i.e. how many radiographs, lab procedures, hours used, patient visits etc.) _____year

b. Is the population base for which this item will be used increasing, decreasing, or remaining stable? _____

c. Will the present workload increase, decrease, or remain stable? _____

d. What effect will this item have on the other services within your facility? _____

SECTION III. MAINTENANCE AND REPAIR DATA ON EQUIPMENT ITEM REQUESTED. (To be completed by a biomedical equipment technician/dental repair technician or equivalent.)

a. Preventive maintenance will be provided by:

(1) Civilian contract yes____ no_____

(a) Company _____

(b) Annual costs $_____

(2) In-house medical repair yes____ no_____

b. If preventive maintenance and repair services are provided by in-house personnel:

(1) Will additional training of repair personnel be required? yes____ no_____

(2) Will additional repair personnel be required? yes____ no_____

(3) Will repair parts present a storage problem? yes____ no_____

(4) Will repair parts be readily available? yes____ no_____

(5) Will additional test equipment be required? yes____ no_____

If yes, describe and state cost: $_____

c. What is the length of the warranty period? _____months

d. Has patient and operator safety been considered? yes____ no_____

SECTION: IV. ITEM OF EQUIPMENT BEING REPLACED DATA

Part A. (To be completed by the requestor)

a. Replacement item name: (use generic term) _____

b. Manufacturer of item being replaced: _____

c. Model of item being replaced: _____

d. Plant property number: _____

Part B. (To be completed by a biomedical equipment technician/dental repair technician or equivalent.)

a. Acquisition cost of item being replaced: $_____

b. Age of item being replaced: _____years

c. Condition code: _____

d. Man-hours of preventive maintenance recommended per year by the manufacturer: _____

e. Man-hours of preventive maintenance actually received per year: _____hours

f. Man-hours of repairs received: _____hours

g. Cost of repair parts: $_____

h. Cost of repair service if provided by commercial contract: $_____

i. Cost of maintenance service contract if provided by commercial contract: $_____

j. Proposed disposition of equipment if replaced: _____

_____

_____

k. Attach copy of NAVMED 6700/3 of the item being replaced.

SECTION V. SPECIAL REPORTING REQUIREMENTS DATA ON ITEM BEING REQUESTED

a. Is the item acquisition cost over $15,000? yes____ no_____

If yes, attach a copy of the life cycle cost in the format of enclosure (4) to BUMEDINST 4235.5 series.

b. Is the item acquisition cost over $100,000? (For X-ray items over $200,000) yes____ no_____

If yes, attach to this request the necessary information requested in enclosure (2) to BUMEDINST 4235.5 series.

c. Does the requested item have an acquisition cost over $200,000? yes____ no_____

If yes, has the local Health System Agency been contracted and documents attached? yes____ no_____

d. Is this item a diagnostic X-ray system, hospital communication system, microfilm equipment, quick copying equipment, word processing (dictation and automatic typing) equipment, filing equipment, automatic data processing equipment, research development, test and evaluation equipment, clinical investigation equipment, vehicular equipment, or nonappropriated funded activity equipment? yes____ no_____

If yes, have the special requirements of BUMEDINST 4235.5 series been submitted? yes____ no_____

SECTION VI. SUMMARY OF COST DATA

a. Total acquisition cost $_____

b. Installation cost
OPN $_____
O&M $_____

c. Annual cost for supplies $_____

d. Annual preventive maintenance & repair cost (if provided by commercial contract). $_____

e. First year's cost of additional training: $_____

f. Annual cost for additional personnel: $_____

g. Cost for additional test equipment: $_____

Total Cost: $_____

SECTION VII. REMARKS: (Provide any additional information which would be beneficial to support the requirements for this item of equipment.)

SECTION VIII. IMPACT IF ITEM OF EQUIPMENT IS NOT PROVIDED IN THE FISCAL YEAR REQUESTED. (e.g. JCAH, patient care, etc.)

REVIEWED BY: _____
GRADE: _____
TITLE: _____

LIFE CYLCE COST ANALYSIS WORKSHEET

Complete for Equipment Items or Systems Costing Over $15,000

Requistion No._____Priority No._____Date_____

Item of Equipment_____

Manufacturer and Model No._____

FY Budgeted_____

Life Expectancy (L): _____years

Purchase Cost (C): $_____

Installation Cost (I): $_____

Annual Cost of Supplies (S): $_____

Annual Maintenance Cost (M): $_____

Annual Labor Cost* (P): $_____

One Time Disposal Cost (D): $_____

Life Cycle Cost Formula** (LCC):

$$LCC = C+I+(SxL)+(MxL)+(PxL)+D =$$

Calcualtions: $\frac{\quad}{C} + \frac{\quad}{I} + \frac{\quad}{(SxL)} + \frac{\quad}{(MxL)} + \frac{\quad}{(PxL)} + \frac{\quad}{D}$

* Include labor cost only if additional personnel are required becouse this item is purchased. This value could be a minus if labor savings are achieved.

** This formula does not take into account the concept of present dollar of future outflows since it would not assist your command or this Bureau in analysis.

APPENDIX B

EQUIPMENT EVALUATION FORM

I. Input Analysis

A. Incremental Acquisition Cost

1. Original invoice cost
2. Transportation cost
3. Training cost
4. Additional working capital
5. Total initial outlay $_____
6. Less salvage values of assets released because of this equipment
7. Less the present value of salvage value and net working capital released at the end of the equipment's economic life $_____
8. Incremental acquisition cost $_____

B. Incremental Operating Cost Per Annum*

9. Training requirements
10. Salaries
11. Fringe benefits
12. Maintenance
13. Supplies
14. Power
15. Other utilities
16. Floor space
17. Other (specify)
18. Incremental operating cost per annum $_____

*. If incremental operating cost per annum are not uniform then they should be computed for each year separately.

C. Computation of Net Outlay Cost

19. Incremental acquisition cost (line 8) $_____
20. Incremental operating cost per annum (line 18)
21. Time adjustment factor _____
22. Time adjusted incremental operating cost for the equipment economic life $_____
23. Total outlay cost $_____

II. Output Analysis

A. Expected Utilization of the Equipment

24. Practical capacity upon 100 per cent utilization (number of occasions per

day if fully utilized 100 per cent of the time)

25. Expected utilization (number of occasions of service expected to be utilized per day)

26. Estimated percentage utilization of equipment (line 25 divided by line 24 times 100) _____%

27. Weighting assigned to this factor (line 26 divided by 4) _____%

B. Patient Life-Saving Potential

28. Will this equipment save patient lives that otherwise would not have been saved?
YES ____ NO ____

a. How many lives over the estimated life of the equipment (zero if none) _____

29. Weighting assigned to this factor (line 27a times 6 with maximum value of 30)_____%

C. Greater Dependability of Service

30. Will this equipment provide a greater dependability of service to the patient?
YES ____ NO ____

31. Weighting assigned to this factor (25 if yes to line 29...zero if no answer to line 29) _____%

D. Better Diagnosis and Evaluation

32. Will this equipment provide a better diagnosis and evaluation of patient needs?
YES ____ NO ____

33. Weighting assigned to this factor (30 if yes answer to line 32, zero if no answer to line 32) _____%

E. Computation of Output Rating

34. Weighting assigned to expected utilization of the equipment (from line 27)

35. Weighting assigned to life-saving potential (from line 29)

36. Weighting assigned to the better diagnosis of service (from line 31)

37. Weighting assigned to the better diagnosis and evaluation (from line 33)

38. Combined weighting assigned to this equipment (sum of lines 34, 35, 36, & 37)
39. Total time available over the estimated life of the equipment (8760 hrs times estimated equipment life in years)
40. Total output rating (line 38 times line 39)

III. Computation Of Index Of Service

41. Total outlay cost over the estimated life of the equipment (from line 23)
42. Total output rating (from line 40)
43. Index of service (line 42 divided by line 41)

APPENDIX C

EQUIPMENT EVALUATION SURVEY FORM

You have 100 pts. to allocate as you see fit to the ten criteria listed below. These points represent the relative consideration you would attach to each criteria when determining ranking of investment equipment. There is no minimum or maximum number of points that must be assigned to each criteria nor must all criteria be assigned any points at all. If you feel that some criteria merits consideration which is not listed please fill it in in question 11 with the appropriate point assignment.

		pts.
1.	Expected utilization time of the equipment (quantity of service)	___
2.	Ability to save patient lives that otherwise would not have been saved	___
3.	Performance of a service that is not presently available	___
4.	Improve utilization of other hospital services that are already available	___
5.	Provide greater comfort to the patient	___
6.	Provide a more uniform test or service than the method currently in use	___
7.	Provide greater safety to the patient	___
8.	Provide greater dependability of service to the patient	___
9.	Permit a more timely completion of service	___
10.	Permit a better diagnosis and evaluation of patient needs	___
11.	Other considerations (explain)	___

Comments:

APPENDIX D

COST DATA RESULTING FROM THE FIELD TEST OF THE METHOD OF ANALYSIS
(10 Per Cent Discount Rate)

	Computed tomographic scanner	Automated blood cell counter	Gas system sterilizer	Portable defribilator	ECG cart
Incremental acquisition cost					
Original invoice cost	$1,395,000	$40,000	$17,442	$6,000	$10,574
Transportation cost	0	0	0	0	0
Installation cost	83,000	0	3,500	0	0
Training cost	80,000	700	0	0	0
Additional working capital	25,000	0	0	0	0
Total initial outlay	1,583,000	40,700	20,942	6,000	10,574
Less salvage value of assets released because of this equipment	0	0	2,400	590	0
Less the present value of salvage value and net working capital released at the end of the equipment's economic life	340,342	12,418	0	0	2,918
Incremental acquisition cost	$1,242,658	$23,282	$18,542	$5,410	$7,656
Incremental operating cost per annum					
Training requirements	0	0	0	0	0
Salaries	24,500	0	0	0	0
Fringe Benefits	6,370	0	0	0	0
Maintenance	80,000	3,000	350	250	1,284
Supplies	26,000	8,000	1,000	500	235
Power	4,000	500	500	1,000	200
Other Utilities	0	0	0	0	0
Floor Space	0	0	0	0	0
Insurance	0	0	0	0	0
Other	0	0	0	0	0
Total operating cost per annum	$140,870	$11,500	$1,850	$1,750	$1,719

APPENDIX E

FIELD TEST OF THE METHOD OF ANALYSIS (SUMMARY)
(Ten Per Cent Discount Rate)

	Computed tomographic scanner	Automated blood cell counter	Gas system sterlizer	Portable defibrilator	ECG Cart
Computation of Net Outlay Cost:					
1. Net incremental acquisition cost	$1,242,658	$ 28,282	$17,442	$ 6,000	$10,574
2. Incremental operating cost	140,870	11,500	1,850	1,750	1,574
3. Time-adjustment factor	6.11	15.94	31.77	15.94	13.58
4. Time-adjusted incremental operating cost for the estimated life of the equipment (line 2 times line 3)	860,716	183,310	58,775	27,895	23,344
5. Net outlay cost over the estimated life of the equipment (line 1 plus line 4)	$2,103,374	$211,592	$76,217	$33,895	$33,918
Computation of Output Rating:					
6. Weighting assigned to expected utilization factor	13%	2%	25%	12%	4%
7. Weighting assigned to life-saving potential factor	30%	-0-	-0-	30%	-0-
8. Weighting assigned to greater dependability of service factor	-0-	30%	30%	30%	30%
9. Weighting assigned to better diagnosis and evaluation factor	30%	30%	-0-	-0-	-0-
10. Combined weightings assigned to this equipment (sum of lines 6,7,8, & 9)	73%	62%	55%	72%	31%
11. Total time available over the estimated life of the equipment	43,800 hrs	87,600 hrs	131,400 hrs	87,600 hrs	78,840 hrs
12. Total output rating	31,974	54,312	72,270	63,072	26,806
13. Net outlay cost over the estimated life of the equipment (line 5)	$2,103,374	$211,592	$76,217	$33,895	$33,918
14. Total output rating (line 12)	31,971	54,312	72,270	63,072	26,806
15. Index of service (line13 / line 14)	0.015	0.257	1.055	1.861	1.265

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7 — 8